S. A. Green.

THE USEFUL ARTS EMPLOYED IN THE CONSTRUCTION OF DWELLING HOUSES.

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PREFACE.

THE dwellings of mankind, at first rude and simple in the extreme, increase in complexity as their inhabitants advance in civilisation. Primitive dwellings are scarcely distinguished by signs of superior skill or sagacity above the holes and nests of the lower animals. The hut of the Hottentot may be considered as an inverted nest, and it is certainly not more ingenious than the nests of many birds; but where man constructs such a habitation for himself, he is invariably in a low state of civilisation. The wants of the bird are few and simple, and the nest is a temporary abode annually constructed and annually deserted: the wants of man, in a state of nature, are almost as limited, and thus the Hottentot's hut affords him as good a nest as he desires. But when he steps forth into the rank which the Creator has destined him to fill; when he feels that he is a responsible being, the creation of an Almighty Power to whom worship is due; when he finds that the productions of the earth are capable of being rendered useful to him by the exercise of his ingenuity, and that his own mental powers are capable of being developed by communion with, and by the assistance of his fellow-men;—then the hut—the inverted nest—is no longer equal to his necessities. He makes implements, and he must have a place to shelter them; he cultivates grain, and he requires a store-house for it; he collects and records the thoughts and the wisdom of his predecessors, and he must have a roof to cover these precious mementos: unlike other animals, he requires *fire* for the preparation of the greater portion of his food; and his fire, as well as his utensils, must be well defended from without:—in short, his wants are so multiplied by the cultivation of his reason, that a *house* has become necessary to him. The beasts of the field and the birds of the air have certain natural instincts given to them which guide them through life, and are perpetuated in their

offspring; the same routine goes on race after race without the operation of what we term improvement. Not so with man: he is a progressive being: he steps forth beyond the limits of mere animal life, and has a mental existence, with wants created by it, and depending on it; wants which are not known to him when considered as a mere animal.

The building of houses has in all ages formed part of the employment of man as he advanced from a state of mere barbarism to one of comparative civilization. In devoting this little volume, therefore, to the subject of the Application of the Useful Arts to the construction of Dwellings, it is necessary to set a limit to so large a subject. A wigwam is a house,—so is a palace, and examples of every possible gradation between the two might be given. In order, then, to avoid the seeming ambition of grasping the whole of this extensive subject we shall not travél out of our own country; nor shall we ascend to the very highest, or descend to the very lowest class of dwellings; but shall describe the principal arts concerned in building a modern English house of moderate rank. In so doing, we shall treat the subject under a few simple heads, classified mainly according to the materials employed.

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Chapter I.

THE WALLS. STONE AND STONE-WORK.

The material mainly employed in the construction of buildings depends partly on the purpose for which the buildings are intended, and still more, perhaps, on the prevailing geological character of the surrounding country. In such a place as London, where there is an immense mass of tenacious clay beneath the vegetable soil, and where solid stone is not to be had, except by bringing it, at a great expense, from a distance of many miles, clay seems to be the natural material for dwellings; and thus we find that almost all the London houses are built of brick formed of clay. In other parts of Great Britain, such as Glasgow or Edinburgh, the case is very different; for, in those places, clay is scarce, and stone is plentiful. There are quarries not far from Edinburgh, and others within the very precincts of Glasgow, where an abundant supply of good building-stone is obtained at a very low rate. Hence it follows as a natural consequence, that the houses in those two cities exhibit a large proportion of stone structures; so much so, indeed, that an inhabitant of London, who is accustomed to see stone appropriated only to large important public buildings, is apt to imagine that the houses in the two northern cities must necessarily be very costly. This is by no means certain, however, for the builders in each city make use of those materials which may be most available.

Whether stone form the main portion of the walls of a house, as in the cases just named, or whether it is only used in smaller degree, as in London houses, the operations by which it is worked and fitted are pretty much the same; and we will therefore devote this chapter to a brief description of the principal kinds of building-stone, followed by an outline of the *Mason's* operations.

Principal Varieties of Building-stone.

Granites are rocks which have been formed by the union of three different minerals in a state of fusion; these, on cooling, have crystallized and become distinct from each other in the mass. It is on the varied proportions in which these three constituents are combined, that the colour, hardness, durability, and beauty of the various granites depend. The light-red and rose-coloured granites contain the felspar in greatest abundance and in the largest crystals; but this mineral varies in hue from the purest white to nearly black; it is the ingredient most acted on by the atmosphere; the rock, therefore, which abounds in it, though it may be more beautiful to the eye, and more easily worked at first, is not so durable as that which contains it in smaller crystals, and with a larger proportion of *quartz*. It is to this last-named mineral that granite owes the sparkling appearance which it presents when the sun shines on it; quartz is the hardest and most imperishable of the three minerals which form the granite-rock. The third, *mica*, is distinguishable from the other two by its satiny, shining, dark hue, and is very apparent in the coarse-grained, handsome stone of our own country, brought from Cornwall.

When the felspar is replaced by another mineral called *hornblende*, the stone is of a dark-greenish hue, and the component parts are in a finer form and less distinguishable from each other. The Aberdeen granite is an example of this kind, which is more durable than the former, though not so pleasing to the eye.

Granite occurs in all the larger mountain-ranges, and in isolated masses in every country; not being a stratified rock, and being excessively hard, it is difficult to quarry and get out in manageable masses. Blasting with gunpowder is the mode usually employed in this country; the pieces detached by this means are hewn roughly into form on the spot by a small pickaxe. Aberdeen granite is quarried by cutting a deep line some yards long, and placing strong iron wedges at equal distances in this line; these wedges are struck in succession by heavy hammers till the mass splits down. This, or analogous modes, may always be employed when the rock approaches a slaty or stratified structure, as is the case with some nearly related to granite. Another method of detaching masses of rock, is by driving wooden wedges into a deep fissure, either natural or artificial; the wedges are then wetted, and the consequent expansion of the wood bursts the rock asunder.

As granite has always to be brought from a great distance to the spot where it is wanted, because its natural localities

are far from the places where edifices are usually constructed, and also on account of its hardness, this rock is only used for important buildings, such as bridges, markets, churches, &c., and not commonly even for these. London and Waterloo bridges, Covent Garden and Hungerford markets, and the York column in Pall Mall, are instances of its use in London.

The principal kinds of stone used in building are the LIMESTONES, or *calcareous rocks* of the geologist; of these it would be useless to describe or enumerate more than a few. In our own country, the *Portland stone*, so called from its principal quarries being in Portland Island, in Dorsetshire, holds the first rank, and is that almost exclusively used in London for building, and for the ornamental parts of edifices. It unites the qualities of being easily sawn and worked, when lately quarried, and of subsequently hardening by exposure to the air; it is close and even in its texture, admitting of being wrought into delicate work, and receiving a very smooth surface, which it will retain for a considerable period, though it is surpassed in durability by many other rocks. It is said that the Banquetting-house, Whitehall, was the first building in London in which this stone was employed. St. Paul's, Westminster and Blackfriars' bridges, Newgate, and, indeed, most of the public buildings of the metropolis, are examples of its use.

Bath-stone, so called from its being entirely used in the neighbourhood of that city, is softer and far less durable than the preceding. When recently quarried, it may be sawn with a toothed saw, like timber, and can be carved with the greatest facility into the richest ornaments; hence it is often employed, and, if sheltered from the weather, is well adapted for such purposes, from its rich, even cream colour; but though it hardens considerably by exposure, it is acted upon, after a time, by the air, so as to render it very perishable. The restoration of Henry the Seventh's Chapel, Westminster, is, unfortunately, made with this stone.

The two preceding, and many others, distinguished by names according to the principal localities, as *Oxford*-stone, *Ketton*-stone, &c., belong to what geologists term the *Oolitic* formation, from the resemblance of some kinds of the rock to fishes' roe, which is observable in that we have last mentioned. They all agree in their principal qualities.

Purbeck-stone, also from Dorsetshire, is used for steps, paving, door-sills, and copings; it is coarser, harder, and less uniform in texture than the foregoing, and not, therefore, calculated for fine buildings, except for the purposes we have specified.

Yorkshire-stone resembles the last; it is used for the same purposes, but especially for paving. The greatest part of the foot-paths in the streets of London are laid with this or the preceding.

Rag-stone is obtained from quarries on the banks of the Thames, Medway, &c. It was the stone chiefly used for building in ancient London, and a great deal is still used for paving.

The lower *chalk*, which is of a grey colour, and contains masses of flint, was formerly much employed for building in the south-western counties of England; its good qualities are proved by the perfect state of many old churches in that part of the kingdom, which are known to be from seven to nine hundred years old. It is now only sparingly used in farm-building and cottages, but it is consumed in vast quantities to burn into lime for mortar and other purposes, and as a manure.

Belonging to the same family of calcareous rocks, and next in utility to those we have just enumerated, though far surpassing them in beauty and value, stand the endless varieties of *Marbles*, essentially characterized by their crystalline texture, superior hardness, and by the absence of shells or organic remains found so abundantly in all other limestones. The name of marble is, however, popularly given to many stones not possessing these characters, but which are hard enough to be susceptible of a high polish, and are ornamental when so treated. In this country the finer kinds of real marble are only sparingly employed in the decorative departments of architecture, such as, for chimney-pieces, slabs, hearths, capitals of columns in halls, saloons, monuments, &c. The secondary kinds are also employed for similar purposes, but more abundantly. The cold white statuary marble is not adapted for out-of-door use in our foggy and cloudy climate, under the influence of which it would soon become dingy and disagreeable, as is proved by the total failure in the effect of the little triumphal arch erected before Buckingham Palace. In Italy many ancient and modern edifices are faced with white marble, and in that clear and pure atmosphere they retain the beauty of the material for ages. The use to which the finest marbles of Greece and Italy are applied in sculpture, is familiar to every one.

The last class of rocks employed in building, in those localities where they occur, are the *Sandstones*, silex, or flint, in finely-comminuted particles agglutinated together, being their principal ingredient; they constitute excellent building-stone, and are abundantly used as such in the West of England.

On Quarrying Stone.

A quarry is an excavation made in the ground, or among rocks, for the purpose of extracting stone for building, or for sculpture. The name appears to have originated in the circumstance that the stones, before they are removed to a distance, are first *quadrated,* or formed into rectangular blocks.

The following may be taken as an example of the general operations of quarrying building-stones. If the stone be vertically below the surface of the ground, the quarrymen first remove the earth and surface soil, and then dig a perpendicular shaft, or pit, to afford access to the stone; but if, as frequently happens, the stone be within the flank of a hill, or mountain, the quarrymen excavate horizontal galleries into the hill, leaving pillars here and there to support the superincumbent mass. Supposing a large quarry about to be opened beneath the soil, the earth is first removed, and then a sort of inferior stone called "rag," which generally lies between the soil and the good stone beneath. Large masses of available stone generally consist of distinct strata lying close together in a kind of cemented bulk, and the contiguous surfaces forming *cleavages,* greatly assist the quarrymen in detaching blocks from the mass. The block is always more easily separated in a direction parallel to these planes of cleavage than in any other direction, and the operations are, therefore, guided by this circumstance. The workmen drive a series of iron wedges into the mass of stone parallel to the cleavage-planes; and, after a few blows, a portion of the mass becomes separated in that direction. They then measure off a portion equal to the intended length and breadth of the stone, and drive their iron wedges similarly in these directions, by which the piece is entirely severed from the rocky mass. The cleavage-planes vary interminably in direction, so that the quarrymen have to work in various positions, according to the direction of stratification. The operations are more easily conducted when the cleavage-planes are vertical, than in any other direction. After the blocks have been severed, they are brought to an irregularly square shape, by means of a tool called a *kevel;* and are finally hoisted by cranes on to low trucks, and conveyed on tramways out of the quarry; or else are hoisted to the surface of the quarry at once, if the depth render that plan necessary.

In quarrying sandstone, and those rocks which consist of regular layers, the pick, the wedge, the hammer, and the pinch, or lever, are the chief tools. But for many kinds of

limestone, and for greenstone and basalt, recourse is had to the more violent and irregular effects of gunpowder. Indeed, some of the primitive rocks, such as granite, gneiss, and sienite, could scarcely be torn asunder by any other means. The great objection to blasting by gunpowder is, that the blocks are broken irregularly, and much of the stone is wasted; but it has the advantage of being simple in its application, and powerful in its effects. The grains of powder are suddenly converted into a permanently elastic air, occupying about four hundred and seventy-two times more space than their own bulk. The elastic fluid expands with a velocity calculated at the rate of about ten thousand feet per second; and its pressure or force, when thus expanding, has been estimated as equal to one thousand atmospheres, that is, one thousand times greater than the atmospheric pressure upon a base of the same extent. By applying this product to a square inch, upon which the atmosphere exerts a pressure of about fifteen pounds, the elastic fluid of the gunpowder will be found, at the moment of the explosion, to exert a force equivalent to six tons and a half upon the square inch of surface exposed to it; and that with a velocity which the imagination can hardly follow.

In boring a rock preparatory to blasting, it is necessary to consider the nature of the stone, and the inclination or dip of the strata, in order to decide upon the diameter, the depth, and direction of the hole for the gunpowder. The diameter of the hole may vary according to the nature of the rock, from half an inch to two and a half inches; and the depth from a few inches to as many feet; the direction may vary to all the angles from the perpendicular to the horizontal. The tools used in this operation are very simple. The chisel, or *jumper*, as it is called, varies in size according to the work to

be performed, and its edge is more or less pointed to suit the hardness of the rock to be bored. If the hole is to be small and not deep, it may be bored by a single person; with one hand he manages the chisel, which he turns at every blow so as to cross the previous cut, and with the other hand he strikes it with a hammer of six or eight pounds' weight, occasionally clearing out the hole by means of a *scraper*. But when the hole is large and deep, one man in a sitting posture directs the jumper, pours water into the hole, and occasionally cleans it out, while two or three men, with hammers of ten or twelve pounds' weight, strike successive blows upon the jumper, until the rock is perforated to the required depth.

To prevent annoyance to the workmen, a small rope of straw or hemp is twisted round the jumper, and made to rest in the orifice of the hole. When the holes are to be made to a greater depth than about thirty inches, it is common to use a chisel from six to eight feet in length, pointed at both ends, having a bulbous part in the middle for the convenience of holding it; it thus becomes a kind of double jumper, and is used without a hammer, with either end put into the hole at pleasure. The workmen holding this jumper by the bulbous part, lift it, and allow it to drop into the hole by its own weight, and by this simple operation, a hole to the depth of five feet and upwards is perforated with ease and expedition. When the boring is completed, the fragments are carefully removed, and the hole is made as dry as possible, which is done by filling it partially with stiff clay, and then driving into it a tapering iron rod, called the *claying bar*, which nearly fills it. This, being forced in with great violence, drives the clay into all the crevices of the rock, and secures the dryness of the hole. Should this plan fail, tin cartridges are used: these are furnished with a stem or tube, as shown in the following figure, through which the powder may be

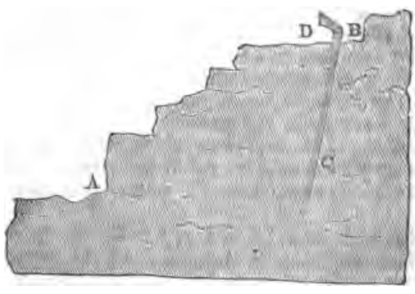
ignited. When the hole is dry, the powder is introduced, mixed sometimes with quicklime, which, it is said, increases the force of the explosion. A long iron or copper rod, called the *pricker*, is then inserted amongst the powder, and is afterwards withdrawn, when the priming powder is introduced. The hole is filled up with burnt clay, pounded brick, stone, or any other substance not likely to produce a spark during the ramming. This is called the *tamping*. In filling up the hole, the chief danger is the production of a spark among the materials, a circumstance which has occasioned the most fatal and distressing accidents to quarriers. Prickers and rammers of copper, or of bronze, have been employed, but their greater expense, and liability to twist and break, have prevented their general introduction.

The quarrier is, of course, accustomed to suppose that the more firmly he rams in the powder, the greater will be the resulting effect. It is, however, a curious property of sand, that it fills up all the void spaces in the tube or hole, and for some rocks entirely supersedes the necessity of ramming and pricking.

When the hole is fully charged with the powder and wadding, the pricker is withdrawn, and the small tubular space, or vent-hole, which it leaves, is sometimes filled up

with powder; but, for the sake of economy, it is more common to insert straws filled with powder, and joined together, so as to reach the required depth. The lower straw is one terminating in the root part, where a natural obstruction occurs, or it is artificially stopped with clay to prevent the powder from being lost. The lower part of the priming straw is pared quite thin, so as to insure the inflammation of the charge of powder in the hole. Sometimes the fire is conveyed by means of the large and long green rushes, which grow in marshy ground. A slit is made in one side of the rush, along which the sharp end of a bit of stick is drawn, so as to extract the pith, when the skin of the rush closes again by its own elasticity. This tube is filled up with gunpowder; it is then dropped into the vent-hole, and made steady with a bit of clay. This being done, a slow match, called a *smift*, consisting generally of a bit of soft paper, prepared by dipping it into a solution of saltpetre, is carefully applied to the priming powder. When this match is about to be fired, the quarriers usually blow a horn or ring a bell, to give notice to all around them to retire. The explosion commonly takes place in about a minute; the priming first explodes, attended only with flame; a short interval of suspense commonly ensues; the eyes of the bystanders being anxiously directed towards the spot; the rock is instantly seen to open, when a sharp report or detonating noise takes place, and numerous fragments of stone are observed to spring into the air, and fly about in all directions, from amidst a cloud of smoke. The quarrier then returns with alacrity to the scene of his operations.

The accompanying figure shows the plan of blasting the rock, and a section of the hole ready prepared for firing. The portion of the rock to be dislodged by the explosion is that included between A and B. The charge of powder is



represented as filling the bore to C, from which point to the top, the hole is filled up with *tamping*. The *swift* is represented at D.

In the year 1831, a patent was taken out by Mr. Bickford, of Tucking Mill, Cornwall, for an invention called "the Miner's Safety Fuse." It consists essentially of a minute cylinder of gunpowder, or other suitable explosive mixture, inclosed within a hempen cord, which is first twisted in a peculiar kind of machine, then overlaid to strengthen it; afterwards it is varnished with a mixture of tar and resin to preserve the powder from moisture, and finally is coated with whitening to prevent the varnish from sticking to the fingers, or the fuses to one another. These fuses are said to have been used with good effect, and to have greatly diminished the number of accidents.

The application of Electricity to the Blasting of Rocks.

Perhaps the greatest modern improvement that has been made in blasting rocks has been by the introduction of the galvanic battery. It is well known that by closing the circuit of a voltaic current by means of thin platinum wire, or by fine iron or steel wire, the platinum becomes red-hot, and the iron or steel becomes instantly fused. All, therefore, that is necessary is to connect the two terminal wires of a voltaic battery by means of a fine wire of platinum or iron, and to bury this in gunpowder contained in a tin canister, or a fuse connected with a deposit of gunpowder. This was the method adopted by Colonel Pasley in removing the Royal George, which lay sunk at the bottom of the water at Spithead. Canisters of gunpowder, sometimes to the extent of three thousand pounds' weight, were employed, and securely deposited in the sunken vessel, by workmen who descended in the diving-bell; the terminal wires of the battery, connected as above stated, having been previously inserted in the canisters, and these wires being extended to a great distance, the explosion took place the instant they were connected with the voltaic battery. After the vessel was thus blown to pieces by repeated explosions, divers descended to clear away the wreck, and to attach guns, &c., to chains let down from a ship above, and which were then hauled up by means of a crane.

Mr. Morgan, in the *American Journal of Science*, describes a fuse or cartridge which he has used with success in connexion with the voltaic battery. This cartridge is prepared by

joining two pieces of clean copper wire to the ends of a fine steel wire, about one quarter of an inch in length, by means of waxed silk; a thin piece of wood is then spliced to both copper wires, to protect the steel wire from accidents, and to enable the maker to introduce it easily into a quill or small paper tube, which is to form the cartridge. This tube is filled with fine gunpowder, and made air and water-tight. Another piece of wood is then attached to this arrangement, and one of the copper wires is bent over so as to form an angle with the straight wire.

When it is required to use this cartridge, the copper wires are rubbed with sand-paper, and twisted round the wires of the voltaic battery. The cartridge is then placed deep in the hole made to receive the gunpowder, and the charge is fired from any distance.

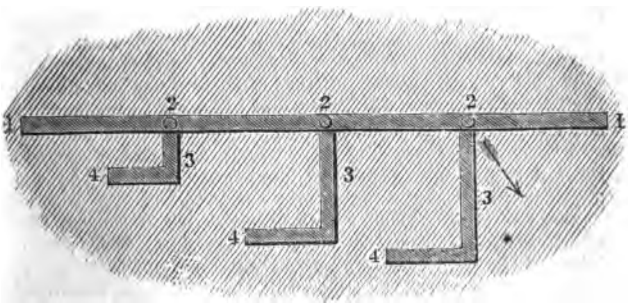
Mr. Morgan found this arrangement very useful in removing stumps of trees; but one of his applications of it was curious and novel: he exploded some powder in a pond at the depth of ten feet, with the battery at the distance of two hundred and ten feet; the explosion, which was instantaneous, had the effect of killing a large eel; and "I have no doubt," says Mr. Morgan, "that wild-fowl will yet be killed by means of shells placed at low-water on the banks where they feed; and by means of long connecting wires, the shells can be made to explode simultaneously among the birds."

But the grandest application of gunpowder and the voltaic battery to the blasting of rocks, was made in the month of January, 1843, at Dover. It was determined by these means to attempt the removal of an enormous mass of the cliff facing the sea, which formed an obstruction to the line of railroad. A portion of the cliff which was penetrated by the tunnel made through Shakspeare's Cliff gave way, about two years previously. About fifty yards of the tunnel were carried away, and a clear space was thus formed for the line of railroad, with the exception of a projecting point, which, prior to the slip alluded to, was the extremity of the part of the cliff pierced by the tunnel, and to remove which was the object of the operation in question.

To clear away this mass by the tedious process of manual labour, would have cost above twelve thousand pounds; and this consideration, as well as the time that would have been lost, induced Mr. Cubitt, the engineer, to try the bold expedient of blowing it away with gunpowder. "It cannot be denied," remarks Captain Stuart, whose account of this great engineering operation we follow, "that there was apparent danger in the undertaking, for the weight of the mass to be removed was estimated at two million tons, and the quantity

of powder used was more than eight tons, or eighteen thousand pounds. The quantity used in blowing up the fortifications of Bhurtpore was twelve thousand pounds, and this is said to have been the greatest explosion that had ever previously taken place for any single specific object."

The front of the projection was about one hundred yards wide; this front was pierced with a tunnel about six feet in height, and three in breadth; three shafts, equidistant from each other, and from the entrances to the tunnel, were sunk to the depth of seventeen feet, and galleries were run, one from each shaft, parallel with each other, and at right angles with the line of the tunnel. These galleries varied in length, the longest having been twenty-six feet, and the shortest twelve feet, and at their extremities chambers were excavated in a direction parallel with the tunnel. This description will be the better understood by reference to the following figure. 1. The tunnel. 2. The shafts. 3. The galleries. 4. The chambers.



In the chambers, the powder was deposited in three nearly equal quantities; it was done up in fifty-pound bags, and the proportion in each chamber was contained in a wooden case, nearly as large as the chamber itself. Ignition was communicated by means of a voltaic battery; the conducting wires, one thousand feet in length, were passed over the cliff, one to each chamber, and the electricity was communicated in a shed built for the purpose on the top of the cliff, about fifty yards from the edge. The explosion was conducted by Lieutenant Hutchinson, R.E., who was engaged with General Pasley in blowing up the wreck of the Royal George. The time appointed for the explosion to take place, was two o'clock P.M., 26th January, 1843, the tide being then at its lowest ebb. The arrangements, to preserve order and

prevent danger, were good. A space was kept clear by a cordon of artillery, and the following programme was issued:—

"Signals, January 26, 1843.

"1st. Fifteen minutes before firing, all the signal flags will be hoisted.

"2nd. Five minutes before firing, one gun will be fired, and all the flags will be hauled down.

"3rd. One minute before firing, two guns will be fired, and all the flags (except that on the point which is to be blasted) will be hoisted up again."

These signals were given exactly at the specified times, and when the expected moment arrived, a deep subterranean sound was heard, a violent commotion was seen at the base of the cliff, and the whole mass slid majestically down, forming an immense *débris* at the bottom. Tremendous cheers followed the blast, and a royal salute was fired.

The remarks of different intelligent observers, as to the effects of this explosion, would of course differ according to their position with respect to the scene of explosion. One observer states that "the earth trembled to the distance of half a mile; a stifled report, not loud, but deep, was heard; the *base* of the cliff, extending on either hand to upwards of five hundred feet, was shot as from a cannon, from under the superincumbent mass of chalk seaward; and in a few seconds not less than a million tons of chalk were dislodged by the shock, and settled gently down into the sea below."

But the most eminent observer who has described the effects of this explosion is Sir John Herschel, from whose letter to the *Athenæum* we gather the following particulars. His position was on the summit of the cliff, next adjoining the scene of operations, to the southward, the nearest point to which access was permitted.

Sir John Herschel was particularly struck with "the singular and almost total absence of all those tumultuous and noisy manifestations of power, which might naturally be expected to accompany the explosion of so enormous a quantity (19,000lbs.) of gunpowder." He describes the noise which accompanied the immediate explosion as "a low murmur, lasting hardly more than half a second, and so faint, that had a companion at my elbow been speaking in an ordinary tone of voice, I doubt not it would have passed unheeded."

The fall of the cliff, the ruins of which extended over no less than eighteen acres of the beach, to an average depth of fourteen feet, was not accompanied with any considerable

noise. "The entire absence of smoke was another and not less remarkable feature of the phenomenon. Much dust, indeed, curled out at the borders of the vast rolling and undulating mass, which spread itself like a semi-fluid body, thinning out in its progress; but this subsided instantly; and of true smoke there was absolutely not a vestige. Every part of the surface was immediately and clearly seen—the prostrate flagstaff (speedily re-erected in the place of its fall)—the broken turf, which a few seconds before had been quietly growing at the summit of the cliff—and every other detail of that extensive field of ruin, were seen immediately in all their distinctness. Full in the midst of what appeared the highest part of the expanding mass, while yet in rapid motion, my attention was attracted by a tumultuous and somewhat upward-swelling motion of the earth, whence I fully expected to see burst forth a volume of pitchy smoke, and from which my present impression is, that gas, purified from carbonaceous matter in passing through innumerable fissures of cold and damp material, was still in progress of escape; but whether so or not, the remark made at the moment is sufficient to prove the absence of any impediment to distinct vision."

The amount of tremor experienced by Sir John Herschel at the point where he was standing was so slight, that he thinks he has felt it surpassed by a heavy waggon passing along a paved street. "The impression, slight as it was, was single and brief, and must have originated with the first shock of the powder, and not from the subsequent and prolonged rush of the ruins." We have already noticed the remark of one observer, that "the earth trembled to the distance of half a mile;" but this seems to be a mistake; the writer fancied that it must have been so, and that he should be suspected if he were to state it otherwise. It is to be regretted that people do not endeavour to describe what they see and hear, without the embellishment of the imagination.

This grand experiment was no less grand from the absence of noise, smoke, earthquake, and fragments hurled to vast distances through the air. "I have not heard of a single scattered fragment flying out as a projectile in any direction"—continues Sir John Herschel—"and altogether the whole phenomenon was totally unlike anything which, according to ordinary ideas, could have been supposed to arise from the action of gunpowder. Strange as it may seem, this contrast between the actual and the expected effects, gave to the whole scene a character rather of sublime composure than of headlong violence—of graceful ease than of struggling effort. How quietly, in short, the gigantic power employed per-

formed its work, may be gathered from the fact, that the operators themselves who discharged the batteries were not aware that they had taken effect, but thought the whole affair a failure, until reassured by the shout which hailed its success."

Sawing the Stones for the Mason.

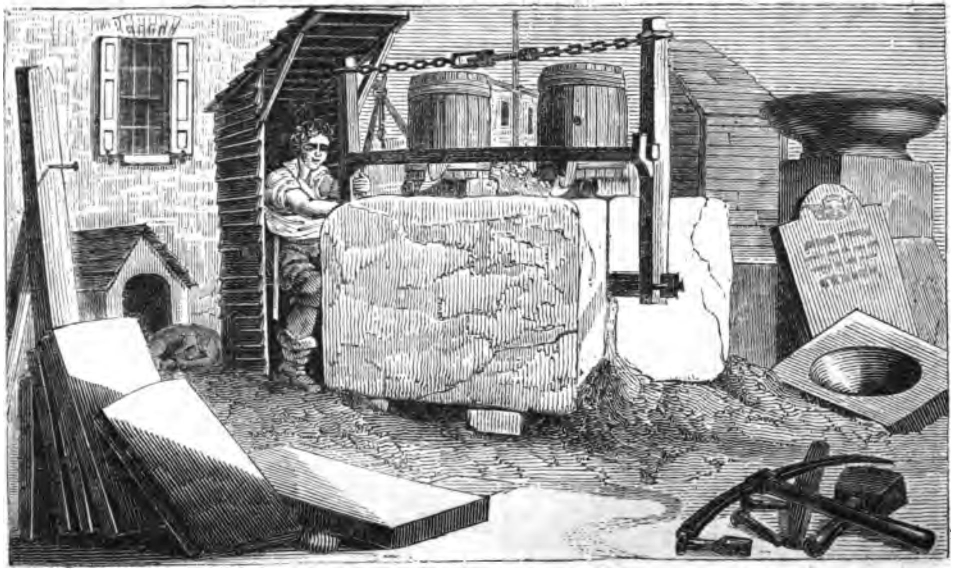
Whatever may be the purpose to which the stone is to be applied, the larger blocks obtained from the quarry must be cut into smaller and more manageable pieces; this is done by *sawing*. The saw used is a long blade of steel without teeth, fixed in a heavy wooden frame, similar in principle to that which holds the finer spring-saws employed by cabinet-makers. The stone-saw, from its great size, however, requires a more powerful contrivance for drawing it to the proper degree of tension: this consists of a long screw-bolt fixed to a piece of chain, which hooks over one of the upright arms of the frame; a similar chain from the other carries a swivel-joint with a screw-nut to receive the screw: by turning the swivel by a lever, the nut on the screw draws up or tightens the chains, and that draws the blade tight, which is contained between the other ends of the arms.

These huge saws are worked by one or two men, who, in London stone-yards, sit in watch-boxes, in order to be sheltered from the sun and rain. Barrels filled with water, which is allowed to drop out at a tap, are mounted on the block of stone, so that the water may drip into the cut and facilitate the motion of the saw by removing some of the friction, as well as prevent it becoming hot, and so losing its temper by the same cause.

In some large establishments, the sawing is effected by machinery. The block is fixed in a proper position, and a group of saws brought to act on it. These saws are all arranged parallel, according to the thickness of the pieces into which the stone is to be cut; and a steam-engine being brought to bear on the whole group, the cutting is effected with great rapidity.

The Processes of Stone-Masonry.

When the stone is sawed to the proper size, the surfaces which are exposed to view, have to be made smooth and even. The tools used by the mason for this purpose consist of iron chisels of different widths, and principally of a sharp-pointed one called a *pointer;* these chisels are struck with a mallet made of a conical-formed lump of hard wood, fixed to a short handle.



Stone-Sawyer.

The *pointer* is used for chipping off the principal roughnesses on the face and edges, and for working the whole face over to bring it level, the workman trying his work by applying a *straight-edge* occasionally to it. When the front and edges are made *true*, the face is sometimes *tooled* over, so as to leave regular furrows in it, according to certain forms, by which the different kinds of work are distinguished. But this practice is going out of use, now that soft free-stone is so much employed in building. In old edifices, such as St. Paul's, Whitehall, &c., &c., the stone will be found to be wrought on its face in the manner alluded to.

Stones in buildings are not only fixed with mortar, as bricks are, but are further secured in their places by being clamped together with iron clamps. These are short iron bars, from seven to twelve inches long, one and a half wide, and half an inch thick, according to the size of the stone; the ends of the clamps being turned down a little, to afford a better hold. A channel is cut in the two contiguous stones deep enough for the clamp to lie in, and the ends of the channel are sunk deeper, to receive the turned-down ends of the clamp; when this is put into the channel, molten lead is poured in to fill up the interstices, to keep the clamp in its place, and to prevent it from rusting.

From the expense of carrying and working stone, the walls of buildings at a distance from a quarry, such for example as those in London, are seldom now built of solid stone, but a facing of this material is applied only on the external surface of the wall, which is built of brick. This kind of work is called *ashler* work, and both the brick and stone-work must be executed with considerable care, to enable a wall composed of two materials to preserve its perpendicularity; it being obvious, that if the brick part yielded to the weight, it must, from its construction, do so more than the stone facing, and, therefore, the wall would bend inwards and become crippled.

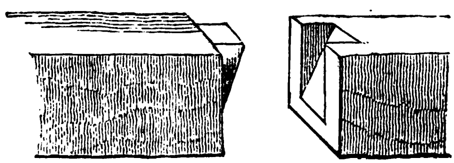
The width of the courses of ashlers must, therefore, be made equal exactly to a certain number of courses of bricks with the intervening mortar, and the brick-work must be executed with such care, that this number of courses may be everywhere of the same width in the whole height of the wall. In every course of ashler there must be solid stones laid quite, or nearly quite, across the width of the wall to form a *bond* to the stone facing, and all the stones of the ashler must be fixed with iron cramps to one another and to these bond-stones. But, however carefully a faced-wall may be executed, it is never so firm or durable as one built entirely of either material; indeed, if well executed, of good

materials, and of competent thickness in proportion to its height, a brick wall is the most durable, light, and efficient structure that can be erected.

When stone is to be cut into cornices, mouldings, &c., the blocks having been sawed, the ends, top and bottom, are worked very true and parallel, or perpendicular to each other, and one edge or *arris* cut to a perfectly straight line; a thin wooden mould of the section of the cornice is then applied to each end, and the profile of the mouldings marked out on the stone. The workman being guided by this figure, cuts away the stone down to the general surface of the mouldings, and then proceeds to get the flat fillets of the mouldings perfectly straight and true by the rule; these again guide him in working the curved mouldings, such as *ovolos, cavettos, cyma rectas,* and *ogees;* when these are cut nearly to their profile, and perfectly straight on the *bed* line, they are finished off by being rubbed down smooth by thin long straight-edges of stone.

Foliage and carved work is executed by a better kind of workman, possessing some of the taste of an artist, and he works on the same general principles as a sculptor when executing a statue; it would be foreign to our present object, therefore, to dwell on this branch of the mason's art.

It often, or even most commonly occurs, that the distance between two columns of a portico, is of greater length than a stone can be obtained, and if the architrave, or that part of the *entablature* immediately over the capitals of the columns, be looked at attentively, a stone will be perceived between the columns apparently unsupported, for neither end rests on the column, and the joints of those ends are upright, not presenting any character of a voussoir-stone or arch. The contrivance by which such an architrave stone is supported deserves to be described.



The stone in question has a projecting part, wrought at each end, of the form shown in the annexed figure; this projection is received into a corresponding cavity, cut in the end of the stone supported by the column, and the joint is thus really an arched or wedge-shaped one, though the bevel

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line is concealed, and the two stones, when put together, present only a vertical joint.

The mason uses *squares*, *levels*, *plumb-lines*, and *straight-edges* to set out his work, and trowels and mortar to set the stones with; but the latter is rather used to make the joints water-tight than to keep the stones together, this being effected by their weight or by iron clamping. Formerly the mason required far more accurate and extensive knowledge of geometry than is possessed by persons of the trade at present; this was when he was called on to construct groined and vaulted roofs, enriched with carved work and pendent corbels, where the nicest workmanship was required, to ensure the stability of the light and graceful columns and vaulting of a Gothic cathedral. It was this possession of superior skill and knowledge that caused the establishment of the Society of Freemasons, which dates its rise from the tenth or eleventh century.

Marble, from its costliness, and the difficulty of working it, is seldom, if ever, used in solid pieces in buildings; thin facings of it are set upon stone *backings*, much as rare woods are used in *veneering* by the cabinet-maker. The marble is sawn into thin slabs, like other stone, and the face is polished by rubbing on it the surface of another piece, fine sand, mixed up with water, being used to cause abrasion.

Various contrivances are resorted to for cutting marble, and building-stones generally, into *curved* forms. In some cases a lever is made to work at one end on a pivot, while at the other end is attached a curved piece of sheet-iron, which passing backwards and forwards over the stone, cuts it in a circular form. In other cases a cylinder of sheet-iron is formed; and this being allowed to fall vertically on the surface of the stone, and rotated rapidly, cuts out a piece of stone of the diameter of the cylinder. Sometimes, when a large circular piece of stone is required, a kind of wheel is employed, furnished on its under surface with four curved cutting-irons, and these cutters, when the wheel revolves, cut the stone. By a modification of the arrangements, an oval instead of a circular curve may be given to the piece of stone.

Chapter II.

ON THE DURABILITY OF STONE BUILDINGS.

On the Choice of a Stone for Building Purposes.

"Everything belonging to the earth, whether in its primitive state, or modified by human hands, is submitted to certain and innumerable laws of destruction, as permanent and universal as those which produce the planetary motions. The operations of nature, when slow, are no less sure; however man may for a time usurp dominion over her, she is certain of recovering her empire. He converts her rocks, her stones, her trees, into forms of palaces, houses, and ships; he employs the metals found in the bosom of the earth as instruments of power, and the sands and clays which constitute its surface as ornaments and resources of luxury; he imprisons air by water, and tortures water by fire to change, to modify, or destroy the natural forms of things. But in some lustrums his works begin to change, and in a few centuries they decay and are in ruins; and his mighty temples, framed, as it were, for divine purposes, and his bridges formed of granite, and ribbed with iron, and his walls for defence, and the splendid monuments by which he has endeavoured to give eternity even to its perishable remains, are gradually destroyed; and these structures which have resisted the waves of the ocean, the tempest of the sky, and the stroke of the lightning, shall yield to the operation of the dews of heaven, of frost, rain, vapour, and imperceptible atmospheric influences; and as the worm devours the lineaments of his mortal beauty, so the lichens and the moss, and the most insignificant plants, shall feed upon his columns and his pyramids, and the most humble and insignificant insect shall undermine and sap the foundations of his colossal works, and make their habitations amongst the ruins of his palaces, and the falling seats of his earthly glory."*

Although it is true that all human works must decay, yet it is a point of great importance to ourselves and our successors whether that decay be slow or speedy. The causes enumerated in the above eloquent passage, though sure, are exceedingly slow in their action, and provided the building materials have been selected with reference as well to their durability as to their beauty, the resulting structure may defy the corroding tooth of time for many ages, and we may thus transmit

* Sir Humphry Davy.

to a long posterity, lasting memorials of our wisdom and science, as well as of our piety. Modern science has, to a very great extent, enabled the architect and builder to determine beforehand what is the durability of any given stone; and it is with great pleasure that we now notice the extensive inquiry made at the suggestion of Mr. Barry, the architect of the new Houses of Parliament, under the Commission issued by Her Majesty's Government, to investigate the qualities of stone in various parts of the kingdom, in order to select that which should best ensure perpetuity to this grand national monument. This commission, consisting of Mr. Barry, Sir H. T. De la Beche, Dr. W. Smith, and Mr. C. H. Smith, visited one hundred and five quarries, and examined one hundred and seventy-five edifices; and their collected specimens were then submitted to tests, both mechanical and chemical, by Professors Daniell and Wheatstone, of King's College, London. In order to leave a permanent record of their labours, the Commissioners published a Report, and deposited in the Museum of Economic Geology, a variety of specimens of the stones which they had collected. From this Report, we select such details as are calculated to serve the purposes of popular instruction. The Commissioners did not consider it necessary to extend their inquiries to granites, porphyries, and other stones of similar character, on account of the enormous expense of converting them to building purposes in decorated edifices, and from a conviction that an equally durable, and in other respects more eligible material, could be obtained for the object in view from among the limestones or sandstones of the kingdom.

The Commissioners soon had striking proofs of the necessity and importance of this inquiry in the lamentable effects of decomposition observable in the greater part of the limestone employed at Oxford; in the magnesian limestones of the Minster, churches, and other public edifices at York; and in the standstones of which the churches and other public buildings at Derby and Newcastle are constructed; and numerous other examples. The unequal state of preservation of many buildings, often produced by the varied quality of the stone employed in them, although it may have been taken from the same quarry, showed the propriety of a minute examination of the quarries themselves, in order to gain a proper knowledge of the particular beds from whence the different varieties have been obtained. An inspection of quarries was also desirable for the purpose of ascertaining their power of supply, and other important matters; for it frequently happens, that the best stone in quarries is often neglected, or only partially worked, in consequence of the cost of laying bare, and

removing those beds with which it may be associated; whence it happens, that the inferior material is in such cases supplied.

Stone buildings decay more rapidly in towns than in the open country, where dense smoke, fogs, and vapours, which act injuriously on buildings, do not exist. There is also another curious cause which contributes to the durability of stone buildings situated in the country. In the course of time, the stone becomes covered with minute lichens, which, though in themselves decomposing agents, act with extreme slowness, and when once firmly established over the entire surface of the stone, seem to exercise a protective influence, by defending the surface from the more violent destructive agents; whereas, in populous smoky towns, these lichens are prevented from forming, and thus the stone is exposed to severer trials than stone of the same kind situated in the country.

As a remarkable illustration of the difference in the degree of durability in the same material, subjected to the effects of the air in town and country, the appearance is noticed of several frusta of columns, and other blocks of stone, that were quarried at the time of the erection of St. Paul's Cathedral, London, and which are now lying in the Isle of Portland, near the quarries from whence they were obtained. These blocks are invariably found to be covered with lichens, and, although they have been exposed to all the vicissitudes of a marine atmosphere for more than one hundred and fifty years, they still exhibit beneath the lichens their original form, even to the marks of the chisel employed upon them; whilst the stone which was taken from the same quarries, (selected no doubt with equal, if not greater care, than the blocks alluded to,) and placed in the Cathedral itself, is, in those parts which are exposed to the south and south-west winds, found, in some instances, to be fast mouldering away.

Colour is more important in the selection of a building-stone to be situated in a populous and smoky town, than for one to be placed in the open country, where all edifices become covered with lichens; for, although in such towns, those fronts which are not exposed to the prevailing winds and rains, will soon become blackened, the remainder of the building will constantly exhibit a tint depending upon the natural colour of the stone.

The chemical action of the atmosphere produces a change in the entire matter of the limestones, and in the cementing substance of sandstones, according to the amount of surface exposed to it. The particles of the stone first loosened by the action of frost are removed by powerful winds and driving rains. The buildings in this climate were generally found to suffer the greatest amount of decomposition on their south,

south-west, and west fronts, arising doubtless from the prevalence of winds and rains from those quarters.

Those buildings which are highly decorated, such as the churches of the Norman and pointed styles of architecture, generally afford a more severe test of the durability of a building-stone, than the more simple and less decorated castles of the fourteenth and fifteenth centuries; because, in the former class of buildings, the stone is worked into more disadvantageous forms than in the latter, as regards exposure to the effects of the weather. Buildings in a state of ruin, from being deprived of their ordinary protection of roofing, glazing of windows, &c., afford an equally severe test of the durability of the stône employed in them.

The durability of various building-stones in particular localities was estimated by examining the condition of the neighbouring buildings constructed of them. Among sandstone buildings was noticed the remains of Ecclestone Abbey, of the thirteenth century, near Barnard Castle, constructed of a stone closely resembling that of the Stenton quarry, in the vicinity, in which the mouldings and other decorations were in excellent condition. The circular keep of Barnard Castle, apparently also built of the same material, is in fine preservation. Tintern Abbey is noticed as a sandstone edifice, that has to a considerable extent resisted decomposition. Some portions of Whitby Abbey are fast yielding to the effects of the atmosphere. The older portions of Ripon Cathedral; Rievaulx Abbey; and the Norman keep of Richmond Castle, in Yorkshire, are all examples of sandstone buildings, in tolerably fair preservation.

Of sandstone edifices in an advanced state of decomposition, are enumerated Durham Cathedral, the churches at Newcastle-upon-Tyne, Carlisle Cathedral, Kirkstall Abbey, and Fountain's Abbey. The sandstone churches of Derby are also extremely decomposed; and the church of St. Peter, at Shaftsbury, is in such a state of decay, that some portions of the building are only prevented from falling by means of iron ties.

The choir of Southwell Church, of the twelfth century, affords an instance of the durability of a magnesio-calciferous sandstone after long exposure to the influences of the atmosphere. The Norman portions of this church are also constructed of magnesian limestone, similar to that of Bolsover Moor, and which are throughout in a perfect state, the mouldings and carved enrichments being as sharp as when first executed. The following buildings, also of magnesian limestone, are either in perfect preservation, or exhibit only slight traces of decay: the keep of Koningsburgh Castle; the

church at Hemingborough, of the fifteenth century; Tickhill Church, of the same date; Huddlestone Hall, of the sixteenth century; Roche Abbey, of the thirteenth century.

The magnesian limestone buildings which were found in a more advanced state of decay, were the churches at York, and a large portion of the Minster, Howden Church, Doncaster Old Church, and buildings in other parts of the county, many of which are so much decomposed, that the mouldings, carvings, &c., are often entirely effaced.

The report speaks in high terms of the preservation of buildings constructed of oolitic and other limestones; such are Byland Abbey, of the twelfth century; Sandysfoot Castle, near Weymouth, constructed of Portland oolite in the time of Henry the Eighth; Bow-and-Arrow Castle, and the neighbouring ruins of a church of the fourteenth century, in the island of Portland.

The oolite in the vicinity of Bath does not seem to wear well.

The excellent condition of the parts which remain of Glastonbury Abbey shows the value of a shelly limestone similar to that of Doulting; whilst the stone employed in Wells Cathedral, apparently of the same kind, and not selected with equal care, is in parts decomposed. In Salisbury Cathedral, built of stone from Chilmark, we have evidence of the general durability of a siliciferous limestone; for, although the west front has somewhat yielded to the effects of the atmosphere, the excellent condition of the building generally is most striking.

The materials employed in the public buildings of Oxford, afford a marked instance both of decomposition and durability; for whilst a shelly oolite, similar to that of Taynton, which is employed in the exposed parts of the more ancient parts of the Cathedral, in Merton College Chapel, &c., is generally in a good state of preservation, a calcareous stone from Heddington, employed in nearly all the colleges, churches, and other public buildings, is in such a deplorable state of decay as, in some instances, to have caused all traces of architectural decoration to disappear, and the ashler itself to be, in many places, deeply disintegrated.

In Spofforth Castle, two materials, a magnesian limestone and a sandstone, have been employed, the former in the decorated parts, and the latter for the ashler, and although both have been equally exposed, the magnesian limestone has remained as perfect in form as when first employed, while the sandstone has suffered considerably from the effects of decomposition. In Chepstow Castle a magnesian limestone is in fine preservation, and a red sandstone rapidly decaying.

A similar result was observed in Bristol Cathedral, which afforded a curious instance of the effects of using different materials; for a yellow limestone and a red sandstone have been indiscriminately employed both for the plain and the decorated parts of the building; not only is the appearance unsightly, but the architectural effect of the edifice is also much impaired by the unequal decomposition of the two materials.

After enumerating these and other examples, the Report gives the preference to the limestones, on account of their more general uniformity of tint, their comparatively homogeneous structure, and the facility and economy of their conversion to building purposes; and, of this class, preference is given to those which are most crystalline. Professor Daniell is of opinion that the nearer the magnesian limestones approach to equivalent proportions of carbonate of lime and carbonate of magnesia, the more crystalline and better they are in every respect.

It was considered that this crystalline character, together with durability, as instanced in Southwell Church, &c.; uniformity in structure; facility and economy in conversion; and advantage in colour, were all comprised in the magnesian limestone, or dolomite of Bolsover* Moor and its neighbourhood, and was accordingly recommended as the most fit and proper material to be employed in the New Houses of Parliament.† This opinion was not arrived at, nor this recommendation made, until after a very extensive series of experiments had been completed by Professors Daniell and Wheatstone upon specimens of the stones of the various quarries visited by the Commissioners. The specimens, as delivered to these gentlemen, were in the form of two-inch cubes. These experiments were of a most comprehensive kind. The composition of the stones was determined by chemical analysis:—their specific gravities; their weights after having been perfectly dried by exposure in heated air for several days; then their weights after having been im-

* Bolsover is a small market town in Derbyshire, on the borders of the county of Nottingham, and about 145 miles from London.

† The various quarries visited by the commissioners are noticed in the fullest and fairest manner. They have stated for each quarry its name and situation; the names and addresses of the freeholder, of his agent, and of the quarryman; the name of the stone; its composition; colour; weight per cubic foot; entire depth of workable stone; description of the beds; size of blocks that can be procured; prices, per cubic foot, of block stone at the quarry; description and cost of carriage to London; cost, per cubic foot, of the stone delivered in London; cost, per foot of surface, of plain rubbed work, as compared with Portland stone; and, finally, where known or reported to have been employed in building.

mersed in water for several days so as to become saturated; the object being to ascertain the absorbent powers of the stones, which was further tested by placing them in water under the exhausted receiver of an air-pump. The stones were also subjected to the process of disintegration, invented by M. Brard, the object of which is to determine, by easy experiments, whether a building-stone will or will not resist the action of frost. Lastly, the cohesive strength of each specimen, or its resistance to pressure, was tested by the weight required to crush it. This weight was furnished by a hydrostatic press, the pump of which was one inch in diameter: one pound at the end of the pump lever produced a pressure on the surface of the cube equal to 2·53 cwt., or to 71·06 lbs. on the square inch. These trials were made with caution; the weight on the lever was successively increased by a single pound; and, in order to ensure a gradual action, a minute was allowed to elapse previous to the application of each additional weight. It was noted for each specimen the pressure at which the stone began to crack, and also the pressure at which it was crushed.

The results of all these experiments (which are stated for each stone) gave a decided preference to the Bolsover magnesian limestone, which was noticed as being remarkable for its peculiarly beautiful crystalline structure, while it was the heaviest and strongest of all the specimens, and absorbed least water. Its composition was 50 per cent. of carbonate of lime, and 40 of carbonate of magnesia; the remaining ten parts consisting chiefly of silica and alumina.

An easy Method of determining whether a Stone will resist the Action of Frost.

In the choice of a stone for building purposes, it is of the utmost importance to be able to determine, by a few prompt and easy experiments, whether the proposed stone is capable of resisting the destructive action of moisture and frost. The means of ascertaining this were difficult and uncertain, until M. Brard, several years ago, communicated his method to the Royal Academy of Sciences at Paris. This learned body having appointed a Committee of their own members to inquire into the merits of M. Brard's process, and to make a report thereon, the united testimony of engineers, architects, masons, and builders from different parts of France, was received, and proved so favourable as to its merits and simplicity, that the Committee recommended the plan to public notice and general adoption. From their Report we

select a few details, which hitherto, we believe, have not appeared in English.

When water is converted into ice an increase in bulk suddenly takes place with such amazing force that it appears to be almost irresistible. This is the force which cracks our water-bottles and ewers; splits asunder the trees of our forests; and destroys some of the stones of our buildings. But the action of frost upon stone is very gradual; it is confined to the surface, and when we see a layer of stone separated from the rock or the building, we see the result of the action of the frost during several successive winters, whereby the fragment is gradually thrust out of its perpendicular position, and at length falls. This natural process is repeated in our buildings: we rarely see squared stones split into large fragments by the action of frost except there be a cavity of some considerable size, in which a quantity of water can be collected. The usual action of the frost is at the surface, which is destroyed by the chipping off of small fragments in consequence of the adhesion of the materials of the stone being partially destroyed.

All stones absorb water in greater or less quantities, and there is no rock that does not contain some humidity. The great difference between stones which is now to be considered is in their power of resisting frost. Stones of the same kind, nay, stones from different parts of the same quarry, are acted upon very differently by frost; for, while one stone soon begins to show the destructive effects of its action, another remains uninjured during many centuries. It will, therefore, be convenient to call those stones, of whatever kind, which withstand the action of frost, *resistant*, and those which yield to its action, *non-resistant*.

M. Brard's first idea, in order to test these resistant properties in building-stones, was, to saturate the stone with water, and then expose it to cold artificially produced; but this was found to be impracticable on a large scale, and the freezing mixtures and other means of producing cold were liable to act chemically upon the stone, and thus produce other effects than those of cold.

M. Brard was then led to compare water with those numerous solutions of the chemist, which, under certain modes of treatment, crystallize. The expansive force of salts in crystallizing is very great, and he saw no reason why water should not be regarded as a crystalline salt similar in its nature to those saline bodies which effloresce at the surfaces of stones, and in time destroy them and even reduce them to powder.

He therefore tried, in a very large number of experiments, the action upon building-stones of solutions of nitre, of com-

mon salt, of Epsom salts, of carbonate and sulphate of soda, of alum and of sulphate of iron, and found that the stones cracked and chipped, and in many cases behaved precisely in the same way as when under the influence of freezing water. In the course of these trials, sulphate of soda (Glauber's salts) was found to be the most energetic and active, and to be the best exponent of the action of freezing water.

In order, therefore, to determine promptly if a stone be resistant or non-resistant, the following process was adopted. A saturated solution of sulphate of soda was made in cold water; the solution being put into a convenient vessel, the stone was immersed, and the solution boiled during half an hour: the stone was then taken out, and placed in a plate containing a little of the solution. It was then left in a cool apartment, in order to facilitate the efflorescence of the salt with which the stone was now impregnated. At the end of about twenty-four hours the stone was covered with a snowy efflorescence, and the liquid had disappeared either by evaporation or by absorption. The stone was then sprinkled gently with cold water until all the saline particles disappeared from the surface. After this first washing the surfaces of the stone were covered with detached grains, scales, and angular fragments, and the stone being one that was easily attacked by frost, the splitting of the surfaces was very marked. But the experiment was not yet terminated: the efflorescence was allowed to form, and the washing was repeated many times during five or six days, at the end of which time the bad qualities of the stone became fully established. The stone was finally washed in pure water; all the detached parts were collected, and by these the ultimate action of the frost upon the stone was estimated.

The behaviour of various non-resistant stones under this process was remarkable. Some were found to have deteriorated in the course of the third day; others to have entirely fallen to pieces; those of which the power of resistance was somewhat greater, held out till the fifth or sixth day; but few stones, except the hard granites, compact limestones, and white marbles, were able to stand the trial during thirty consecutive days. For all useful purposes, however, eight days suffice to test the resistant qualities of any building-stone.

The explanation of this process is very easy. The boiling solution dilates the stone and penetrates it to a certain depth, nearly in the same way that rain water by long-continued action introduces itself into stones exposed to the severity of our changeable climate. Pure water when frozen occupies a greater bulk than when fluid, and the pores or cellules of the

stone not being able to accommodate themselves to the increased bulk of the water, great pressure is exerted between and among them, whereby a portion of the water is driven to the surface, and in doing so rends and detaches small portions of the stone. The same action takes place with the saline solution; it is introduced into the stone in a fluid state, from which passing into the solid it occupies a greater bulk, and a portion of it appears at the surface. The repeated washings have no other object than to allow the salt to exert its greatest amount of destructive action upon the stone. There is a striking analogy between the effect of congealed water and that of the efflorescence of salts, in the disintegration of non-resistant stones; namely, that pure water acts on the stones destructively only in a state of snowy efflorescence, which evidently proceeds from the interior to the exterior like the saline efflorescence; whilst water at the surface of the stones may freeze into hard ice without injuring them, just in the same way as salts, which may crystallize upon stones without exerting any injurious action.

The experience of several engineers, extending as it does over several years, fully proves, of a large variety of stones whose qualities were well known, that the action of M. Brard's process and that of long-continued frost exactly coincide.

It is not the least interesting part of the inquiry to know that this process may be applied with perfect success to ascertain the solidity and resistant power of bricks, tiles, slates, and even mortar. From a mass of minute detail, we will select a few general results.

During one winter season M. Vicat composed seventy-five varieties of mortar, the difference between any two consisting in the proportion of sand and the method of slaking the lime. In the following June these mortars were exposed to the disintegrating process. Most of them were attacked in twenty-four hours; almost all of them in forty-eight hours; and all except two in three days. This gentleman also found that a mortar made ten years previously, of one hundred parts lime, which had been left exposed to the air, under cover, during a whole year, and then mixed up into a paste with fifty parts of common sand, withstood the trial admirably during seventeen days, while the best stones of the neighbourhood speedily gave way. In this case the solution was saturated while hot, which is so powerful in its effects that stones which have resisted the action of the frost for ages, soon gave way when exposed to it.

M. Vicat calculates that the effect of the sulphate of soda upon a non-resistant stone after the second day of trial equals

a force somewhat greater than that exerted by a temperature of about 21° Fahrenheit, on a stone saturated with water.

The action of the process upon bricks proved that, whatever their qualities in other respects, if imperfectly burnt, they are speedily acted on. The sharp edges of the brick, and then the angles, are first rounded, and finally the brick is reduced to powder. Such is precisely the action of frost often repeated. Well-baked bricks, on the contrary, retain their colour, form, and solidity by this process, as well as under the influence of frost. Ancient Roman bricks, tiles, and mortar, and hard well-baked pottery resisted the process perfectly; as did also white statuary marble of the finest quality, while common white marble was soon attacked. In Paris, portions of buildings which had been exposed to the air during twenty years without undergoing the least alteration, were submitted to this ordeal, and the experiment agreed with observation. In one extensive series of experiments on stones from different quarries of France, the action of the salt was continued for seven days, and the results noted down; it was then continued for fourteen days, and the results compared with the preceding ones; which only served to confirm the judgment first given, for those stones which were noted as of bad quality crumbled to dust or split into fragments, while those noted for their good qualities had experienced no sensible alteration.

One of the great advantages of this process is the power it gives to the architect of choosing a hard, durable stone for those parts of the building most exposed to the action of the weather, when the funds are insufficient to admit of the whole building being so constructed. Thus the cornices, the columns, and their capitals, are struck in all directions by rain, and hail, and damp air, and are consequently far more exposed to their destructive action than the flat surface of a wall, which offers but one plane to the air.

In the course of this inquiry a very curious case arose. During the erection of a church in Paris, the architect required a good durable stone for the Corinthian capitals; and many circumstances disposed him to select it from the neighbouring quarry of the Abbaye du Val. But, on seeking the opinion of two brother architects, he was surprised to find their estimations of the stone to be totally at variance, for while one declared that he had employed it with the greatest success, another said that he had seen it yield speedily to the effects of frost. On visiting the quarry it was found that two beds of stone were being worked, an upper and a lower bed; specimens of the stone were taken from each, and on submitting them to a hot saturated solution, it was

ascertained almost immediately that the upper layer furnished excellent stone, while the lower one supplied that of which the architect had so much reason to complain. But it is remarkable that the stones from the two beds had precisely the same appearance in grain, colour, and texture; so much so, that when brought into the mason's yard it was impossible by ordinary tests to distinguish the good from the bad stone.

At the conclusion of the inquiry of the Committee, the Royal Academy of Sciences proved the high estimation in which they held this contribution of science to the useful arts, by directing to be published the following practical directions for repeating the process, for the use of architects, builders, master masons, land proprietors, and all persons engaged in building.

1. The specimens of stone are to be chosen from those parts of the quarry, where from certain observed differences in the colour, grain, and general appearance of the stone, its quality is doubtful.

2. The specimens are to be formed into two-inch cubes, carefully cut, so that the edges may be sharp.

3. Each stone is to be marked or numbered with Indian ink or scratched with a steel point; and corresponding with such mark or number a written account is to be kept as to the situation of the quarry, the exact spot whence the stone was detached, and other notes and information relating to the specimen.

4. Continue to add a quantity of sulphate of soda to rain or distilled water, until it will dissolve no more. You may be quite sure that the solution is saturated, if, after repeatedly stirring it, a little of the salt remains undissolved at the bottom of the vessel an hour or two after it has been put in.

5. This solution may be heated in almost any kind of vessel usually put on the fire, but perhaps an earthen pipkin may be most convenient. When the solution boils, put in the specimens of stone, one by one, so that all may be completely sunk in it.

6. Continue the boiling for thirty minutes. Be careful in observing this direction.

7. Take out the cubes one at a time, and hang them up by threads in such a way that they may touch nothing. Place under each specimen a vessel containing a portion of the liquid in which the stones were boiled, having first strained it to remove all dirt, dust, &c.

8. If the weather be not very damp or cold the surfaces of each stone will, in the course of twenty-four hours, be-

come covered with little white saline needles. Plunge each stone into the vessel below it, so as to wash off these little crystals, and repeat this two or three times a day.

9. If the stone be one that will resist the action of frost, the crystals will abstract nothing from the stone, and there will be found at the bottom of the vessel neither grains, nor scales, nor fragments of stone. Be careful, in dipping the stone, not to displace the vessel.

If, on the contrary, the stone is one that will not resist the action of frost, this will be discovered as soon as the salt appears on the surface, for the salt will chip off little particles of the stone, which will be found in the vessel beneath; the cube will soon lose its sharp edges and angles; and by about the fifth day from the first appearance of the salt, the experiment may be considered at an end.

As soon as the salt begins to appear at the surface its deposit is assisted by dipping the stone five or six times a day into the solution.

10. In order to compare the resisting powers of two stones which are acted upon by the frost in different degrees, all that is necessary is, to collect all the fragments detached from the six faces of the cube, dry them and weigh them, and the greatest weight will indicate the stone of least resistance to the frost. Thus, if a cube of twenty-four inches of surface loses 180 grains, and a similar cube only 90 grains, the latter is evidently better adapted than the former to the purposes of building.

Chapter III.

THE WALLS. BRICKS AND BRICK-WORK.

We now come to that material which is, in England, a more important agent than stone in the construction of dwelling-houses; namely, *bricks* made from clay. There were three millions and a half of houses in Great Britain in the year 1841; and there can be no doubt that of this number those which were built of brick constituted a vast majority. It is only in a few particular districts that stone is a more available material for houses than bricks. In other countries, too, as well as our own, the arts of brick-making and brick-laying are carried on more extensively than the operations of the stone-mason.

Bricks and Brick-work in Early Times.

It has been observed that "the art of making bricks is so simple, that it must have been practised in the earliest ages of the world; probably before mankind had discovered the method of fashioning stones to suit the purposes of building." It is stated in the Book of Genesis that burnt bricks were employed in the construction of the Tower of Babel. Now, as this structure appears to have been raised about four hundred years after the Deluge, it is scarcely an exaggeration to say that the art of making bricks was invented almost as soon as men began to build. Bricks seem to have been in common use in Egypt while the Israelites were in subjection to that nation; for the task assigned them was the making of brick, and we are informed in the Book of Exodus, that the Israelites built two Egyptian cities. No particulars are given in Scripture of the method of making bricks; but as straw was one of the ingredients, and as very little rain falls in Egypt, it is probable that their bricks were not burned, but merely baked by the heat of the sun. The same mode of baking bricks seems still to be practised in the East. The ruins of the tower near Bagdad are formed of unburnt bricks. The art of brick-making was carried to considerable perfection among the Greeks. Pliny states that they made use of bricks of three sizes, distinguished by the following names: *didoron*, or six inches long; *tetradoron*, or twelve inches long; and *pentadoron*, or fifteen inches long. That the Romans excelled in the art of making bricks there is the amplest evidence, since brick structures raised at Rome seventeen hundred years ago, still remain nearly as entire as when first built.

A remarkable kind of *floating brick*, used by the ancients, has been made the subject of investigation in modern times, with a view to the suggestion of improvements in the making of bricks for particular purposes. Pliny states that at various places in Spain, in Asia Minor, and elsewhere, bricks were made which, besides possessing considerable strength and a remarkable power of enduring heat, were yet of such small specific gravity, that they floated on the surface of water. Like many of the arts of the ancients, the method of making these bricks, as well as the material of which they were made, were forgotten for many ages. About the year 1790, however, an Italian, named Fabbroni, turned his attention to the subject, and after various experiments on minerals of small specific gravity, he came to the conclusion that these bricks must have been composed of a substance called "mountain-meal;" or, at least, he found that he could make of this substance bricks which appeared to agree in every respect with those described by the ancients. This mountain-meal is an earth composed of flint, magnesia, clay, lime, iron, and water, in certain definite proportions. The bricks which Fabbroni formed of this material had the property of floating in water; they could not be fused by any ordinary degree of heat; and so low was their conducting power, that while one end of the brick was red-hot, the other could be held in the hand without the smallest inconvenience. It has been supposed that a peculiar kind of earth, found in some parts of Cornwall is the same as that with which Fabbroni experimented on in Italy, and that both are analogous to the kind of which the ancients made their floating bricks. Proceeding on this supposition, it has been proposed to make such bricks for the construction of *floating houses* upon ornamental waters. At present such structures can be made only of timber; and, however the owner may decorate them, they have always a flimsy and unsubstantial appearance, and they are soon injured by the weather. If, however, a platform of good timber were employed as the base of the whole, and the weight so contrived as to keep this platform constantly under water, it would last a long time. The upper part of the structure formed of the floating bricks, might have all the appearance, and, indeed, all the stability of a brick house upon land; for this description of brick resists the influence of the atmosphere as well as the action of fire; and although it is not absolutely so strong as the heavy brick in common use, it is far more so in proportion to its specific gravity. We do not know whether these conjectures have yet been put to the test.

That the early inhabitants of many countries in the eastern

and central parts of Asia were acquainted with the use of bricks in building, we have abundant proof from the descriptions of intelligent travellers; and there are even grounds for attributing to them a very high degree of mechanical skill both in the making of the bricks and the formation of brick walls. Dr. Kennedy, in his *Campaign of the Indus*, says:—"Nothing I have ever seen has at all equalled the perfection of the early brick-making, which is shown in the bricks to be found in these ruins [ancient tombs near Tatta]: the most beautifully chiselled stone could not surpass the sharpness of edge, and angle, and accuracy of form; whilst the substance was so perfectly homogeneous and skilfully burned, that each brick had a metallic ring, and fractured with a clear surface, like breaking freestone. I will not question the possibility of manufacturing such bricks in England, but I much doubt whether such perfect work has ever been attempted."

Making Bricks by Hand.

In the mechanical arrangements for making bricks two very different systems are adopted; the one handicraft, and the other by machinery. The former has always been and still is far more extensively adopted than the latter.

In the selection of materials for brick-making, a brown loamy clay, that is, clay which contains a small quantity of calcareous matter, is considered best for ordinary bricks, but the ingredients vary according to the purposes for which the brick is required; and every one must have remarked the difference in colour between the light yellow *marl stocks*, as they are called, employed in the facing of houses of the better kind, and the dark red brick used in Lancashire and other northern counties. The colour also varies with the proportion of ashes or sand employed in the mixture, and with the degree of heat they are subjected to in drying. The general process is, however, much the same everywhere; and we shall describe that used in England, where bricks are always *burnt*.

The proper kind of clay being found, the top vegetable mould is removed, and the earth dug and turned over to expose it as much as possible to atmospheric action, and for this purpose it is left for the winter. In spring, a quantity of fine ashes, varying in proportion to the clay from one-fourth to a fifth, according to the stiffness of the latter, is added by degrees, and well incorporated by digging and raking, water being poured on to render the mass soft. When the union is effected, the clay is carried in barrows

to a rude mill, erected near the shed, in which the brick-maker works.

This mill consists usually of a vat, or circular vessel, fixed on a timber frame; an upright iron axle is placed in the centre of the vat, and carries some iron plates, or rakes with teeth, to stir up the soft clay when placed in the mill: this axle is turned round by a horse harnessed to a horizontal shaft which proceeds from the axle. The clay being put into the vat, the rakes or *knives* complete the incorporation of the ashes, and thoroughly temper the whole mass, which is gradually squeezed out through a hole in the bottom of the vat.

A better kind of mill is used in tempering the material for the better bricks; it only differs, however, in being larger. An iron harrow loaded with weights is dragged round in a circular pit lined with brick-work. The clay in this case is diluted with water sufficiently to allow of the stones sinking to the bottom; and the fluid is drawn off into pits, where it is left to settle and thicken, to the proper consistence.

The prepared clay is first separated into masses, each large enough to make a brick, by the *feeder*, or assistant, who sands the pieces ready for the *moulder;* the *mould* is an open rectangular box, the four sides of which are made to separate from the bottom, to allow of the brick being turned out. The bottom is now made with a lump raised on it, by which a slight depression is formed on one side of the brick, to admit a mass of the mortar being received and detained in it when the wall is built.

The moulder takes the piece of clay prepared for him, and dashing each into the mould so as to cause it to fill it, removes the superfluous quantity by means of a flat piece of wood which he draws across the open side of the mould; this *strike* is kept in a bowl of water to wet it, and prevent the adhesion to it of the clay. The man then lifts off the sides of the mould, and deposits the brick on a flat *pallet-board*, and this is removed by a boy who ranges the bricks on a lattice frame set sloping on the barrow in which they are to be taken to the field to dry; fine sand is strewed on the frame and over the bricks, to prevent their adhering together.

The bricks are taken to the field, and piled in long lines called *hacks*. This is a nice operation, as the soft bricks, if handled roughly, would become twisted, and rendered useless; the bottom course of bricks is raised a few inches to keep it from the wet; and the ground is prepared to receive them by being covered with dry brick-rubbish or ashes, and

raked smooth. The bricks are set alternately in rows lengthwise and crosswise, with intervals between them of an inch or more, to allow a thorough circulation of air: the hack, when raised about a yard high, is covered over with straw to throw off the rain.

If the weather be favourable, ten or twelve days are enough to dry the bricks in the hacks sufficiently to prepare them for burning, but they should be thoroughly dry, or the subsequent process will fail.

Ordinary bricks for building are burnt in *clamps*, which are large oblong masses, built up of the unburnt bricks, laid regularly in layers, with large flues or passages at intervals, in which ashes, cinders, coal, and brush-wood are laid; layers of ashes are strewed over those of the bricks. The object is, that the fire, when the fuel is ignited, may penetrate every part of the mass, and bake every brick equally; even the ashes mixed up in the clay are intended to be partly burnt by the heat. In clamps well constructed, the outside is coated with clay or plaster to keep in the heat, and when the fuel is thoroughly lighted, the external apertures should be stopped up.

The clamp when completed contains from 100,000 to 500,000 bricks. The fire will continue burning about three weeks, if the pile has been well constructed: when all smoke ceases to rise, the clamp is taken down when cold, and the bricks sorted; for, even with the utmost care, it must happen that the bricks are not all equally burnt. The best are those in the centre. The under-burnt ones are reserved to be rebuilt into a new clamp for further baking, and those which are overdone, and have run together by partial vitrification, are sold at a cheap rate for making foundations for houses, roads, &c.

The better or peculiar kinds of bricks, as well as tiles of all kinds, are burnt in kilns instead of clamps. These kilns, though of a peculiar form, according to the purpose to which they are applied, yet do not differ in principle from the lime-kiln, &c. In the kiln, the fire is not intermixed with the bricks, but is applied beneath; nor are ashes mingled with the clay of which kiln-burnt bricks are made.

As the general principles are the same in making tiles and bricks, we shall class all these coarse pottery-works together here, in an enumeration of the most important kinds used in Britain.

Place-Bricks are the worst of the clamp-burnt stocks, and are used for common walls, and the poorest kinds of work; they are soft and unequally burnt; they sell from 20*s*. to 30*s*. a thousand.

Stock-Bricks are those from the centre of the clamp, and are regularly burnt, of an equally hard texture, and even colour;

they are used for good work of all kinds; the price varies from 30*s*. to 40*s*. a thousand.

Malm-Stocks are clamp bricks, but made with more care from clay to which ooze, chalk, or marl is added; and the whole carefully tempered; they are of a fine clear yellow colour, and are used for facing the walls of good houses, and for making arches over doors and windows in general, where they are to be seen. The softest kind are called *cutters*, from their admitting of being cut, or trimmed, with the trowel with nicety. The prices of these bricks vary greatly.

Fire-Bricks are made of a peculiar kind of clay, found in perfection at Windsor, Stourbridge, and parts of Wales, whence the varieties derive their names. They are formed from the clay without any admixture of ashes, and are always kiln-burnt. They vary in size, and are used for building furnaces, ovens, boilers, &c.

Pan-Tiles are tiles, the cross section of which may be represented thus.  They are used for roofing outhouses, stables, &c., the edges of one row overlapping those of another next it, and they are always set in mortar: the end of the tile is formed with a projecting knob or fillet, by means of which the tile is hooked on to the batten or lath. These tiles are much larger than the *Plain-Tiles*, which are used in roofing dwellings, &c.; they are flat, as the name indicates, and are fixed to the laths of the roof by wooden pegs, two holes being left in the tile for that purpose. Foot and ten-inch tiles are thick square tiles of those dimensions, used for paving, hearths, &c., or for coping walls. All tiles are burnt in a kiln.

Bricks made in Great Britain are charged with a duty, and as it constitutes an important item in the revenue, the manufacture is laid under strict surveillance by the Excise. The duty on tiles was repealed in the year 1833. Bricks can only be made at certain seasons, in certain quantities, and even the screen through which the ashes are sifted, to be mingled with the clay, must be made of wire of a certain mesh. Bricks made larger than the standard measure of 8½ inches long, 4 wide, and 2½ thick, pay a higher duty than the common ones; if the bricks are smaller than the proper size, the maker is fined heavily. No duty is charged upon bricks made in Ireland.

About 1500 millions of bricks, 42 millions of plain, 23 millions pan, and 6 millions of other tiles, are made annually in Britain. A good moulder can make from 5000 to 6000 bricks in a day, from five A.M. to eight P.M.

Within the present century, the annual use of bricks in Great Britain has more than doubled, owing to the increase of

manufactories, and to the construction of railroads and other public works.

Making Bricks by Machinery.

Within the last few years the making of bricks and tiles by machinery has occupied much attention. A large number of patents has been taken out for contrivances having this object in view. In some cases the patentee has directed his attention chiefly to the preparation of bricks for houses; while in others the making of tiles for draining has been the chief object. A description of one or two of these contrivances will give an idea of the general character of the whole.

The Marquis of Tweeddale, having his attention drawn to the importance of employing draining tiles in agriculture, directed his talents to the invention of a machine which should make them so quickly as to enable them to be sold at a low price. After many attempts, he perfected a machine which worked out this object, and at the same time possessed all the facilities for making common bricks. The machine is not constructed on the principle of imitating the manual operation, by forming the bricks in moulds; but it arrives at the same end in a different and remarkable manner. The principle adopted is, to form and protrude, by mechanical means, a continuous fillet of clay, of the proper width and thickness for a brick, and to stop this act of protrusion for a moment, whilst a length of the fillet equal to that of a brick is cut off. This is effected by the following mechanical arrangements: — Two vertical roller-wheels, one of them being placed over the other, and having an interval between them equal to the thickness of the intended bricks or tiles, are made to revolve in contrary directions; consequently they draw between them the clay with which they are fed on the one side (either by hand or by any mechanical contrivance), and deliver it on the other in a highly compressed state, and in the form of a straight, smooth, and even fillet of the width of the rollers. To provide for the squareness and smoothness of the sides of the fillet, the sides of the aperture through which the clay passes are made square and neat, so as to prevent the clay from spreading out laterally. The clay is supported in a horizontal position whilst delivered to and received from the rollers, upon a short endless band on each side revolving on rollers rather close together; and in order to facilitate this object the rollers themselves have bands, which are prolonged in the direction of the endless bands in such a manner as to meet them, and form one horizontal line of support. These bands are made of fustian, the nap of which prevents the adhesion of the clay. The rollers are so acted on by the

working power that they protrude a length of clay equal to the required length of the brick or tile, and then stopping, they allow time for a straight stretched wire to descend and cut off the brick or tile, after which the motion between the rollers is resumed, until another length is protruded, and so on continuously. The fillet of clay is double the width for a brick, and a wire is kept constantly stretched in the middle of its path, dividing it into two fillets, so that two bricks are cut off at once. Two boys are sufficient to remove the bricks as fast as they are produced, which is at the rate of from fifteen to eighteen hundred in an hour. The consistence of the clay is so much stiffer than that used for hand-made bricks, that only half the time is required in the drying. From there being so little water in the clay, and from its undergoing so much compression, the bricks produced are remarkably dense and strong, weighing half as much again as the ordinary brick, and absorbing only one-seventh as much water.

Many machines have been contrived, having for their object the formation of bricks on a principle somewhat analogous. Another class of machines have effected the desired end in a different way,—viz., by forming each brick separately in a mould. A slight description of one machine of this kind will illustrate all the others. The main part of the machine is a horizontal wheel of large diameter. Round the periphery of this wheel is a series of moulds, the exact size and shape for bricks, placed nearly close together. Each mould has a loose bottom, incapable of falling below the mould, but capable of rising to its upper edge. The clay for the bricks, being properly prepared in vessels at one side of the wheel, is made to fall into one of the moulds, and the superfluous quantity is scraped off by a flat edge which passes over the mould. The wheel rotates, and in its movement it passes over a circular inclined plane, so constructed as to lift the bottom of the mould up, so as to protrude the newly-made brick above the mould, where it can be conveniently taken off by the hand. All the different moulds, perhaps thirty or forty in number, are at any given instant in different conditions as to their quota of clay; one is receiving the clay, another is having the superfluous clay scraped off, another has travelled so far round as to have the brick lifted halfway out of it, another presents the brick wholly out of the mould, ready to be taken off, while the others are travelling on empty to receive a new supply of clay, all the moveable bottoms gradually sinking to their proper position as the wheel proceeds, so that one rotation of the wheel carries each mould through all its different stages of position.

The Processes of Bricklaying.

When we consider that a wall forty or fifty feet high, and not more than two feet thick at the bottom, and fourteen or fifteen inches thick at the top, is constructed of such small bodies as bricks, we may well suppose that considerable nicety in workmanship must be requisite to give stability to such a structure. The uniformity in size in the bricks themselves, arising from their being *copies* of one mould, is obviously the first condition that tends to the object; the next is, that they should be put together in such a way as to cause them mutually to adhere, independently of the tenacity of the mortar employed; and lastly, the bricks must be set with great attention, that their surfaces may be perfectly parallel and perpendicular to the direction of gravity, for otherwise the wall composed of them, instead of being truly perpendicular, would lean over on one side and fall. We shall enter into some particulars on these points, but first we must describe the tools and materials used in Bricklaying.

The *trowel* is the first and most indispensable of these tools. It is a thin, flat, lozenge-shaped blade of steel, fixed into a handle. It is with the trowel the workman takes up and spreads the layer of mortar put between each brick, and with it he also *cuts* the bricks so as to fit into any corner, or to adapt them to some particular form; and to enable it to cut, or rather chip, such a hard substance as burnt clay, and yet not break, it is necessary that the blade should be of well-tempered hard steel. The *square* and *level* are made of wooden rules put together; the first at a true right angle, to enable the bricklayer to set out his walls correctly perpendicular to each other,—the second is framed like a $\perp$, with a plummet hanging in a slit in the upright piece; now, as the two rules are correctly perpendicular to each other, it is clear that when the first is set by means of the plumb-line perpendicular to the horizon, the other will be truly horizontal. By means of this important instrument, the workman guides his work, so that the wall he is building shall be upright, and the courses of bricks composing it horizontal.

Mortar is the name given to the composition with which the bricks are put together. Good mortar should be made of newly-burnt quick-lime from grey limestone, and of clean river-sand, in the proportions of one-third lime to two-thirds sand. The lime is *slaked* by pouring a little clean water on it, and when it falls to powder by the chemical action, the sand is added gradually, and the whole well mixed up with a spade, more water being used till the mass is of the proper

consistence for spreading easily. As the adhesion of the bricks depends on the mortar being applied before it begins to *set* or harden, it should not be mixed till it is to be used. When these simple precautions are attended to, the mortar becomes in time as hard as stone, and the brick-work constructed with it is nearly as indestructible. It was by taking this care with their materials that our forefathers built walls that have stood uninjured for centuries. In some of the cheap common buildings of the present day, mortar is too often made from lime which has been so long from the kiln, that it is nearly reconverted into a hydrate, and has lost the chemical quality which renders it valuable; the sand, too, is taken from the road with all its impurities, and the water from the nearest kennel. With such materials a mass of mortar is made, and suffered to stand for several days before it is used; the consequence is, that such buildings are neither safe nor durable.

The mortar is made up by an assistant, called a bricklayers' labourer, and is taken by him to the spot where the workman wants it in what is called a *hod:* this utensil, which consists of three sides of a rectangular box fixed edgeways at the end of a long handle, is expressly contrived to be carried on the man's shoulder, and leave his hands disengaged, to enable him thus loaded to ascend and descend a long ladder; the hod being held standing upright on the handle, the labourer can put bricks into it with his right hand, or another assistant fills it with mortar.

The manner in which the bricks are arranged in the work, is termed *bond,* and is of different kinds, according to the thickness of the wall, and the purposes for which it is intended. The bond most generally used is termed *Flemish,* in which the bricks are laid alternately lengthwise and across the thickness of the wall, the broadest side of the brick being laid horizontal, and never edgeways, in building *walls* of every thickness. It was formerly usual to lay a whole course of bricks lengthwise, and that above it across; this disposition may be seen in old walls, and was termed *English-bond.* In every kind of bond, the joints of the bricks of one course are always made to fall over a brick in that beneath, or so that one joint may never be immediately over another.

The site of a wall, or the walls of a building, being *set out* or marked on the ground, a trench is dug in the earth for the foundations, the width and depth being determined on from the thickness and height of the superstructure, and from the nature of the soil. If this be loose or soft, and the edifice be an important one, it is often necessary to drive piles into the bottom of the trench, and lay a course of oak planking on the

tops of these timbers, to form a firm foundation for the wall; but if the nature of the ground do not require such precautions, it is only necessary to level the bottom of the trench carefully, as on this the stability of the wall will entirely depend. A course of bricks is then laid dry on the earth, forming a band twice the width of the lowermost thickness of the wall to be built. This and the subsequent courses of the foundations should be constructed of the best bricks; but unfortunately in common houses this obvious requisite is entirely neglected. When this course is laid, thin mortar, or mortar almost fluid and having but little sand in it, is poured over the bricks, so as to flow into the joints and bind them together by hardening: a second course is then laid on the first, only narrower in width, and each subsequent course diminishes in the same regular manner on each side, till the width is reduced to the thickness at which it is proposed that the lower part of the wall should be built. A cross section of these foundations thus constructed would present the outline of a truncated pyramid, diminishing by regular sets-off or steps; this part of a wall is called the *footings*. For garden walls, or such as have no weight to carry, the footings need not be made of so many courses, nor so broad, but every wall must have two courses at least for a foundation.

The bricklayer makes use of a string stretched between two pins, to enable him to keep his work straight; and he lays the outermost bricks, those forming the face of the wall, carefully by this guide, setting each brick alternately lengthwise and transversely, and spreading a layer of mortar on the brick beneath, to form a bed for the new one to lie on, and also a layer between each upright joint. It is usual only to lay the outer bricks in this manner, and to fill up the interstices of those forming the interior of the wall by pouring mortar on each course previously laid dry with sufficient interval between them. The workman as he proceeds, repeatedly makes use of his level and square; by the former, he examines whether the face of his wall, and all the corners, or *arrises*, are correctly perpendicular, and whether the courses of bricks are laid horizontal.

Apertures, such as windows or doors which are to be formed in the wall, are marked out on the wall when the work is built up to the height where they are to commence; in carrying up the *piers* between these windows, it will frequently happen that the width of the pier is not precisely commensurate with a certain number of bricks or half-bricks, but that a brick must be cut to bring the work to the correct dimensions. This smaller piece is termed a *closure*, and is usually placed within a brick or two of the arris of the

window or door, and preserves its place for the whole height of the pier.

The thickness of brick walls is described by the number of bricks' length they contain in that direction: thus a nine-inch wall is one-brick thick; a brick-and-a-half wall is fourteen inches: a two-brick wall is eighteen inches thick, and so on. The walls of small houses are often only one brick thick, even when they are two stories high; but usually a wall to be steady should decrease in thickness half a brick at least every story, and for a large substantial building of four or five stories, the main walls should be two-and-a-half bricks at least on the basement story, and one-and-a-half at the top; but of course the size of the apartments, or, in fact, the area of wall which is to remain without any lateral support, must govern the strength of it, as well as the total height to which it is to be raised.

When the wall is raised as high as the tops of the windows, &c., which were left in it, these apertures must have arches turned over them, to support the brick-work above. This leads us to consider the different modes of constructing brick arches. When the width of the opening is not above three or four feet, the arch over it is frequently straight in its outline, or but slightly curved in the intrado or lower line. The bricks which are to form the arch are rubbed down on a board till they are brought to the proper wedge form. A piece of wood for a centering is supported in the opening by upright slips: the upper side of this centering is, of course, cut to the true *camber* or curve the intrado of the arch is to have: the bricks are set upright on this centre, and alternately, so as to break the joints. The face of the arch, which is seen in the street over the windows and doors, is constructed of the best bricks, carefully cut to a mould and set in *putty*, or in thin mortar made of lime only: the rest of the arch behind this face is less carefully constructed, and the bricks are often not cut at all, but made to form an arch by the intervening layer of mortar being spread unequally thick, or in a wedge shape. When, however, a large arch is to be built of bricks, these are cut to the proper level to form the wedge-shaped voussoirs. The construction of groined arches in brick-work is the most difficult operation in the trade. Each brick that forms the arris or intersection of the cross vaults requires to be cut to a true form given by a drawing made to the full size on a board. Another perhaps still more delicate piece of workmanship for a bricklayer to execute is an oblique arch, such as are often seen in the bridges over railroads and canals, which cut established roadways obliquely. These arches are portions of a cylinder, but the ends of the

cylinder. instead of being perpendicular to the axis, are oblique to it, and this requires that the courses of bricks composing the arch shall also not be parallel to the axis, and therefore not in straight lines: hence, every brick has to be cut or rubbed to a wedge form in two directions, and great nicety in this and the subsequent operations are requisite in these structures.

Formerly columns, pilasters, cornices, niches, and similar architectural embellishments, were constructed in brick-work, but stone has now superseded brick for all embellishments; and the bricklayer's greatest skill is only required in the construction of arches, or occasionally building a circular wall. The best specimens of elaborate brick-work of the old school may be seen at the conservatory of Kensington Palace, at Burlington House, and many other edifices of the time of William and Mary, and Queen Anne, throughout the country. The series of arches extending for nearly four miles on the Greenwich Railway, and those for nearly an equal distance on the Blackwall Railway, are perhaps among the best and most imposing specimens of modern brick-work, and afford, in many places, beautiful examples of the oblique arch. There are brick arches of a large span at each end of the new London and Waterloo bridges.

Brick-work is measured by the *rod*, which is a superficial area of sixteen and a half feet each side, or 272 square feet, at a thickness of one-and-a-half brick, and all plain wall-work is reduced to this standard for valuation. A rod of brick-work contains 4500 bricks, and together with the mortar required to build it, weighs about 15 tons 8 cwt. It differs in value from 10*l.* to 15*l.*, according to circumstances.

Besides building walls, bricklayers are employed to tile roofs, set coppers, pave stables, &c., build drains, and, in short, on all occasions where bricks or tiles are the materials used.

Defects of Modern Brick Houses.

A writer in the *Encyclopædia Britannica* endeavours, with much ingenuity, to show that the quality of English bricks and the system of bricklaying are very much influenced by the customary leasehold tenure of land. His remarks are as follow:—" Brick-making has been carried to great perfection by the Dutch, who have long been in the habit of forming their floors, and even, in some cases, of paving their streets with bricks. And it is remarkable how long their bricks will continue unimpaired in such situations. Though brick-making has long been carried on in England, and espe-

cially in the neighbourhood of London, upon a very great scale, and though the process upon the whole is conducted in this country with very considerable skill, yet it must be acknowledged that English bricks are by no means so durable as Dutch bricks. We are disposed to ascribe this inferiority not so much to the nature of the materials employed in the manufacture of English bricks, as to the mode most frequently adopted in London of building houses. Few of the London houses, comparatively speaking, are freeholds. Most of them are built upon ground let for a lease of a certain number of years, which seldom exceeds ninety-nine years. After the expiration of this period the house becomes the property of the landlord who let the ground. Thus it becomes the interest of the builder to construct the house so that it shall last only as long as the lease. Hence the goodness of the bricks becomes only a secondary object. Their cheapness is the principal point. The object, therefore, of the brickmaker is not to furnish durable bricks, but to make them at as cheap a rate as possible. Accordingly, the saving of manual labour and of fuel has been carried by the makers of London bricks to very great lengths. We cannot but consider this mode of proceeding as very objectionable, and as entailing a much heavier expense upon London than would have been incurred had twice the original price been laid out upon the bricks when they were first used, and had the houses been constructed to last a thousand instead of a hundred years. No doubt certain advantages attend these ephemeral structures. The inhabitants are enabled, once every century, to suit their houses to the prevailing taste of the day; and thus there are no (few?) antiquated houses in London. But as the increase of the price of all the materials of building has more than kept pace with the increase of the wealth of individuals, it is to be questioned whether the houses are always improved when they are pulled down and rebuilt."

Chapter IV.

THE ROOF. SLATES, AND OTHER ROOF COVERINGS.

We might, perhaps, under the designation of "Slates and Slating," have included the operations usually understood to appertain to the construction of a roof. But modern improvements have rendered such a designation incomplete. We cannot now properly understand the mode of roofing houses without referring to many other substances besides slate.

Slate-Quarries.

Slate is the popular name for a variety of rocks which are sufficiently stratified in their structure to allow of their being cleaved into thin plates, a property which renders them valuable for a variety of purposes. Slate has superseded the use of lead for covering roofs, even of the largest buildings: from its lightness it is preferable to tile, but the latter being cheaper, in flat countries which do not contain rocks, but which yield brick-clay, slate in such localities is only used on the better class of houses. In mountainous countries, a slaty rock, which admits of being split thin, though not so much as clay slate, is used under the name of *shingle*.

Besides being employed for roofing, slate is used in large slabs to form cisterns, for shelves in dairies, for pavement, and similar purposes, for which its great strength and durability, coolness, and the ease with which it can be cleaned, owing to its non-absorbing property, adapt it. The latter quality renders it also of great value as a cheap substitute for paper, in the business of education; the system of teaching in large classes in National and Sunday-schools would be greatly fettered but for the use of slates.

The principal slate-quarries in Britain are in Wales, Cumberland, and various parts of Scotland; the mode of working them is generally the same. The rock is got out in tabular masses by means of large wedges, and is then subdivided by smaller to the requisite thinness; the pieces are roughly squared by a *pick*, or axe, and sorted, according to their sizes, for roofing. The largest called *imperial*, are about three and a half feet long, and two and a half wide; the smallest average half those dimensions. When wanted for paving, &c., the large blocks are *sawn* into thinner slabs, in the same manner as stone or marble is.

A few words respecting the position and working of some

A Slate-Quarry.

of the slate-quarries may be appropriate, as illustrating the nature of this remarkable geological formation.

The most extensive slate-quarries in Great Britain are those near Bangor, in Wales, from which slate is shipped to all parts of the world. The slate occupies the greater part of the distance from Snowdon to the Menai Straits. Upwards of two thousand men are employed in these quarries; and the proprietor is said to gain from thirty to forty thousand pounds per annum by them. Although this one is the largest, yet there is one in Cumberland in which the slate is found more remarkably situated. This is Hourston Crag, a mountain near Buttermere Lake, about two thousand feet above the level of the lake, and nearly perpendicular. On account of the difficulty of access, the workmen take their provisions for the week, and sleep in temporary huts on the summit. During the winter months they are generally involved in clouds, and not unfrequently blocked up by the snow. The slate is conveyed on sledges down a zigzag path cut in the rock, one man attending to prevent the acceleration of the descent. When the slate is emptied at the bottom the sledge is carried back on the man's shoulders to the summit.

Notwithstanding the value of slate, few quarries are worked to a very great depth, or have subterranean galleries like mines. There is one, however, near Charleville, in France, which is an exception to this rule. The mouth of the mine is near the summit of a hill; the bed inclines forty degrees to the horizon, and is about sixty feet in thickness, but the extent and depth are unknown. It has been worked by a principal gallery to the depth of four hundred feet, and many lateral galleries have also been driven, extending about two hundred feet on the side of the main gallery. Twenty-six ladders are so placed as to give passage to the workmen and carriage for the slate. Of the sixty feet which constitutes the thickness of the bed of slate, about forty are good slate, the rest being mixed with quartz. The slate is cut into blocks of about two hundred pounds each, called *faix*; each workman, in his turn, carrying them on his back to the very mouth of the pit, mounting all or part of the twenty-six ladders, according to the depth of the bed where he may be working. When brought to the surface, these blocks are split into thick tables called *repartons*, by means of a chisel and mallet; and these repartons are divided by similar means into roofing-slates.

Another remarkable slate-quarry in France, is situated near Angers. The bed of slate extends for a space of two leagues, passing under the town of Angers, which is in great

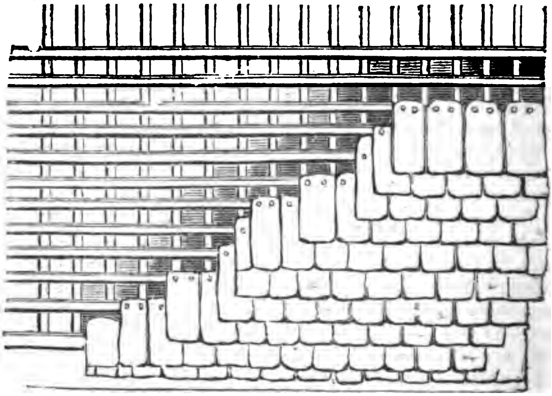
part built of slate; those blocks which are the least divisible being employed in masonry. The quarries actually explored are all in the same line, from west to east, as well as the ancient pits, the bed of the best roof-slate rising to the surface in this direction. Immediately under the vegetable earth is found a brittle kind of slate, which, to a depth of four or five feet, splits into rhomboidal fragments. A little lower is the building-stone, which is a finer but scarcely divisible slate, and is employed in the construction of houses, after it has been sufficiently hardened by exposure to the air. At fourteen or fifteen feet from the surface is found the good slate, which has been quarried to the perpendicular depth of three hundred feet, without its lower limit being attained. The interior structure of the slaty mass is divided by many veins or seams of calcareous spar and quartz, fifteen or sixteen feet in length, by two feet thick; these veins are parallel, and proceed regularly from west to east in a position rising seventy degrees to the south; they are intersected by other veins at intervals of a similar kind, but whose rise is seventy degrees north; so that when the two series meet, they form rhombs or half-rhombs. All the layers or laminæ of slate have a direction similar to those of the veins of quartz, so that the whole mass becomes divided into immense parallel rhomboids. The slate is extracted in blocks of a determinate size, which are then divided into leaves for roof-slates. When the blocks have been drawn from the quarry, if they are left exposed to the sun or the open air, they lose what is called the *quarry-water*, and then become hard and untractable, and can only be employed as building-stone. Frost produces a singular effect on these blocks; while frozen, they may be broken with more ease than before; but if thawed rather quickly, they become no longer divisible; yet this quality may be restored by exposing them once more to the frost.

The Process of Slating.

When the blocks of slate for roofing have been split, and the laminæ roughly squared, they are sorted, according to their size and quality, and are brought to market under the quaint names of *Imperial slates, Duchesses, Countesses, &c.*, the first variety being the largest. The best roofing-slates come from the celebrated vale of Festiniog.

Slates are laid on *battens*, or thin narrow deal boards, which are nailed horizontally on the common rafters of the roof, at equal distances apart, which distance is governed by the size of the slate to be employed. An entire board is nailed along the lowest edge of the roof to receive the lead of the gutters, which are first laid, and then the lowest *course* of slates are

nailed and pinned down to the lowermost batten; so that two-thirds the length of the slate, at least, shall lie over the lead. The next course of slates is then fixed, so that every slate shall overlap two-thirds the depth of the course below it, every slate being also laid over the joint, between two slates of that undercourse. By this construction the rain that runs through the joint between any two slates is kept from penetrating into the roof by being received on the surface of the slate beneath that joint; and the bottom course of slates is double, to continue the same principle down to the lead gutter.



The slates are fixed to the battens by two copper nails and a wooden pin when the work is well executed; holes being picked through each slate for the nails to pass through.

Paper Roofs.

Although, as intimated in a former page, in covering our imaginary dwelling with tiles or slates, we may seem to have done all that is necessary in respect to "roofing," yet we should leave our subject only half treated if we were to omit mention of other contrivances which have been partially acted on; such as the use of paper, of asphaltum, and various other substances.

About thirty years ago, Mr. Loudon published a pamphlet, in which he described the mode of preparing paper for roofs, and discussed the various arguments for and against its adoption. His description had immediate relation to a series of paper roofs in a large farm at Tew Lodge, in Oxfordshire, and comprised the following among other particulars.

Paper roofs may be made very flat, being raised no higher than just sufficient for throwing off the water. Instead of tile, slate, or thatch, they are covered with paper, prepared by immersion in a mixture of tar and pitch. In the first place, pieces of wood called "couples," are laid across the walls of the building, rising two inches and a half to the foot to obtain a drainage obliquity; these couples vary from two or three to six inches square, according to the size of the roof. On the couples are placed horizontal rafters, about two inches square; the distance between the couples being from five to eight feet, and between the rafters about eighteen inches; the couples are nailed to the wall plate, and the rafters to the couples. At Tew Lodge, the rafters used were young larch-trees, sawn up the middle, cut to the proper lengths, and prepared so that the upper surface should be level. On the rafters are placed thin boards, from a half to five-eighths of an inch in thickness; these boards are nailed to the rafters, not horizontally as for slating, but in a direction from the eaves to the ridge of the roof. In some cases substitutes for thin boards may be used; such as close copsewood hurdles, plastered over; or common plaster-laths.

The paper employed may be any common, coarse, strong kind; that kind used by button-makers being favourable for the purpose. It is prepared as follows: a boiler or cauldron, three feet wide by two deep, placed over a fire, is filled to within six inches of the top with tar and pitch, in the proportion of three parts of the former to one of the latter; the fire being applied and the mixture made to boil, the paper is immersed in it one sheet at a time, and then laid in a stack or pile with such a slope as to allow it to drain, a little grease of any kind being placed between the sheets to prevent their adhering; and when dry the paper is similarly treated a second time. The paper thus prepared is then nailed down to the roof. The workman begins at the eaves, and allows three inches for being turned down and nailed underneath the end of the board, which boards project an inch over the first rafter. If the paper be common, coarse, wrapping paper, it is laid on much the same as slate, so that when finished it will remain in double thickness all over the roof; but if thicker paper be employed, it is only made to overlap about three inches in each layer. Every sheet is fixed down with four nails about an inch in length, having broad flat heads.

On the paper thus fixed is laid a composition consisting of two parts of tar to one of pitch, thickened to the consistence of paste, with equal parts of whiting and powdered charcoal. The composition being well boiled and kept constantly stirred, it is spread over the roof with a hempen mop as

quickly as possible on account of the speedy cooling. When properly laid on and dried, the composition totally conceals the joints of the paper, and forms a smooth and glossy black covering an eighth of an inch in thickness. Sometimes, while the composition is yet wet, sand, dust, or ashes are strewed on, to increase the substance, and shield the composition from the action of the sun.

Mr. Loudon enumerates as the advantages of this roof—economy, durability, and elegance. The economy is shown by the circumstance that, on account of the lightness of the paper, less massive walls and timbers are required than for other kinds of roof. The expense at Tew Lodge was from fourpence to tenpence per square foot, everything included. It is one result of the flatness of the roof, that ten square feet will cover as much as fourteen feet at the usual pitch of slated roofs. As to the durability, many proofs are adduced to support it. A paper roof to a church at Dunfermline remained forty years without requiring any repairs; and several warehouses at Greenock, Deal, Dover, and Canterbury, had paper roofs, which were known to stand from ten to twenty years. Mr. Loudon considered that, from the flatness of the roofs, and from other circumstances connected with the appearance of the prepared sheets, the paper roofs were more fitted to join harmoniously with certain styles of architecture than slated roofs.

Objections have been made to this kind of roof, on the ground that it is liable to be blown off by high wind, and still more that it is very inflammable. With regard to the former, Mr. Loudon states that if the roof be properly made there is little danger of its being removed by high wind. In reference to the second objection, he states:—"They seem to me not so liable to set fire to as thatch. Pitch (especially if coated over with sand or smithy ashes) will not be lighted by a spark, nor even by the application of a slender flame, as will that material; though, on the other hand, when lighted, it will unquestionably burn with greater velocity than any species of thatching. . . . . In the steward's house and men's lodge wood is constantly used as fuel, which, though more dangerous for emitting sparks than coal, yet no accident has or is ever likely to happen to the roof. In my house, where coals were chiefly used, the chimneys have been repeatedly set on fire to clean them, without the least accident happening to the roof."

Many years afterwards, when Mr. Loudon published his elaborate *Encyclopædia of Cottage, Farm, and Villa Architecture*, he briefly sketched some of the forms of roof which have more or less recently come into use. These we must here notice.

Terrace Roofs.

Terrace roofs have been much used in and about London. They are formed of thin arches of tiles and cement, supported on cast-iron bearers or ribs, which are placed about three feet apart. The arch is composed of three courses of common plain tiles, bedded in fine cement without sand. In laying the tiles, laths or small slips of wood are used, resting on temporary bearers between the iron ribs; the laths being shifted as the work advances, in the course of about half an hour after the tiles are laid. Particular attention is required in bonding the tiles both ways; and they are rubbed down closely upon each other, much in the same manner as a joiner glues a joint. Sometimes these terrace roofs are coated with a layer of coarse gravel, and then with nine inches of good soil, so as to form a terrace garden. The roofs of two taverns at Hungerford Market are formed of these cemented tiles.

Asphalte Roofs.

Asphalte or *bitumen* has come into use as a material for roofs. It had been employed for various purposes in France for many years, but did not attract much attention till within the last eight or ten years. It is now in very general use in that country for foot pavements, flat roofs, and water-cistern linings; and in England it has also been a good deal used for the same purposes, and for barn-flooring. The particular modes in which it is employed for floors and pavements we need not here consider, but it has been used for roofs in the following manner. Mr. Pocock has patented a "flexible Asphaltic roofing," intended to supersede the use of slates, tiles, zinc, thatch, &c., in the covering and lining of farm-buildings, sheds, cottages, and other erections; and it is approved for its durability, lightness, and economy. The weight of this material being only sixty pounds to the square of one hundred feet, the walls and timbers to support it need to be but half the usual substance; it is also a non-conductor of heat, impervious to damp, and will bear a heat of two hundred and twenty degrees without injury. This peculiar material is said to be formed of asphalte mixed with the refuse felt of hat manufactories, compressed into thin plates.

Scotch Fir Roofs.

Scotch fir roofs are occasionally made. The method of giving durability to the timber for this purpose consists in first cutting the wood to the required size, and then steeping

it for a fortnight in a pond of lime-water; it is found that the acid contained in the wood becomes crystallized by combining with the alkali of the lime. Sir Charles Menteath is said to have some farm buildings which, although roofed with Scotch fir forty years ago, are as well protected now as when the roofs were first laid on; the wood having been previously steeped in lime-water. The sulphate of copper, the chloride of zinc, the corrosive sublimate, and the various other chemical substances which have been recommended of late years as means for preventing the decay of timber, will possibly render the use of timber roofs more practicable than it has been hitherto considered.

Iron Roofs.

Roofs of iron are in great request at the present time. One of these sorts of roofs may be formed of three kinds of cast-iron plates. The first, called the "roof-plate," is shaped with three of its sides turned up and one turned down, and is made tapering narrower towards one end; the second, called the "low-ridge plate," has two of its sides turned up and the other two turned down; the third, called the "high-ridge plate," has all its sides turned down, and is formed with an angle in the middle, so as to slope each way of the roof. Such a roof may be made very flat, inasmuch, that for a house twenty feet wide, the height of the roof in the middle need not exceed two feet; no boarding is required, the plates resting without either cement or nails on the rafters. From the manner in which the edges of the plates overlap, there is no risk of contraction or expansion.

Some of the iron roofs recently made are on the principle of those used in Russia, of which the following description has been given in the *Repertory of Patent Inventions*:—"Sheet-iron coverings are now universally made use of in all new buildings at Petersburgh, Moscow, &c. In the case of a fire, no harm can come to a house from sparks falling on a roof of this description. The sheets of this iron covering measure two feet four inches by four feet eight inches, and weigh twelve pounds and a half avoirdupois per sheet, or one pound five ounces each superficial square foot. When the sheets are on the roof, they measure only two feet wide by four feet in length: this is owing to the overlapping. They are first painted on both sides once, and, when fixed on the roof, a second coat is given. The common colour is red, but green paint, it is said, will stand twice the time. Small bits or ears are introduced into the laps, for nailing the plates to the two-inch square laths on which they are secured. It takes

twelve sheets and a half to cover one hundred feet, the weight of which is one hundred and fifty pounds—the cost only £1 15*s*., or about threepence per foot."

Iron roofs are now often made of *corrugated* or *furrowed* sheet-iron. In this form the iron is impressed so as to present a surface of semi-circular ridges with intervening furrows lengthwise of the sheets. By this means, a piece of sheet-iron, which, as a plain flat surface, has no strength but in its tenacity, becomes a series of continued arches abutting against each other; and the metal, by this new position, acquires increased strength. Iron so furrowed is deemed preferable to common sheet-iron for covering a flat-roof, because the furrows will collect the water and carry it more rapidly to the eaves. But there are greater advantages than this. If the furrowed sheets be bent into a curved surface, convex above and concave below, they will form an arch of great strength, capable of serving as a roof without rafters or any other support, except at the eaves or abutments. Iron roofs measuring two hundred and twenty-five feet by forty have been constructed in this manner. To increase their durability the iron sheets are coated with paint or tar.

Zinc and other Metallic Roofs.

Additions are made every year to the number of contrivances for forming metallic roofs, among which is one now the subject of a patent, for the use of *galvanized* iron. In this case the aid of the electric agent is employed to give iron sheets an amount of durability which they do not possess in their natural state.

Zinc has been much employed within the last few years as a material for roofs. Its availability for this purpose rests partly on its superior lightness as compared with lead, and its superior condition under the action of the atmosphere as compared with iron. The latter quality arises thus; after the zinc has been covered with a thin film of oxide by the action of the atmosphere, it suffers no further change from long exposure; so that the evil of rust checks itself. At the temperature of boiling water, zinc sheets, which are brittle when cold, become malleable, and their availability for roofs is thereby increased. The property which zinc has, however, of taking fire at a temperature of about 700° Fahr., rather detracts from its value as a material for roofs.

Thatch Roofs.

The most common material employed as thatch is either the straw of wheat, rye, or other grain, or reed, stubble, or

heather. The straw of wheat and rye, when well prepared and laid, forms the neatest and most secure thatching; the former being preferable to the latter in smoothness, suppleness, and durability. Barley-straw is placed next to rye in fitness for thatch, and oat-straw the lowest of the four. The reed is a very durable material for thatch, but is generally too expensive. It has been stated that, in Norfolk, where the reed is a favourite material for thatch, a reed roof will lie fifty years without wanting repair, and that, with very slight attention, it will last for a whole century. Viewed in this light, a reed roof may probably be considered economical.

The method of thatching with reed, (which is one of the best and most difficult specimens of the thatcher's art,) has been thus described. No laths being made use of as a support to the thatch, a few of the longest and stoutest reeds are scattered irregularly across the naked spars as a foundation whereon to lay the main coat; and thus a partial gauze-like covering is formed, called the *fleaking*. On this fleaking the main covering is laid, and fastened down to the spars by means of long rods called *sways*, laid across the middle of the reed, and tied to the spars with rope-yarn or with brambles. In laying on the reed, the workman begins at the lower corner of the roof on his right hand, and keeps an irregular diagonal line until he reaches the upper corner on his left; a narrow eaves-board being nailed across the feet of the spars, and some fleaking scattered on. The thatcher begins to "set his eaves" by laying a coat of reed, eight or ten inches thick, with the heads resting upon the fleaking and the butts upon the eaves-board. He then lays on his sway, or rod, about six or eight inches from the lowest point of the reed, whilst his assistant, on the inside, runs a needle threaded with rope-yarn close to the spar and to the upper edge of the eaves-board. The thatcher draws it through on one side of the sway and enters it again on the contrary side both of the sway and of the spar. The assistant, in his turn, draws it through, unthreads it, and, with the two ends of the yarn, makes a knot round the spar, thereby drawing both the sway and the reed tight down to the roof; whilst the thatcher above, beating and pressing the sway, assists in consolidating the work. The assistant, having made good the knot below, proceeds with another length of thread to the next spar, and so on till the sway is bound down the whole length, that is, about eight or ten feet. This being done, another stratum of reed is laid upon the first, so as to make the entire coat eighteen or twenty inches thick at the butts; and another sway is laid on and bound down about twelve inches above the first.

When the eaves are completely set they are adjusted and made even by an instrument called a *legget*. This is made of a board eight or nine inches square, with a handle two feet long adjusted to its upper surface in an oblique position. The face of the legget is set with large-headed nails, and these enable the workman, by using the instrument somewhat as if it were a turf-beating tool, to lay hold of the butts of the reed and to adjust them in their places. When the eaves are thus shaped, the thatcher lays on another stratum of reeds, and binds it down by another sway somewhat shorter than the last, and placed eighteen or twenty inches above it; and above this, others, in successive rows, continuing to shorten the sways until they diminish to nothing, and a triangular corner of thatching be formed. After this the remaining surface of the roof is similarly done.

In order to finish the ridge of the roof, a *cap* of straw is adjusted to it in a very careful manner. In this operation the workman begins by bringing the ridge to a sharp angle, by laying straw lengthwise upon it: and to keep this straw in its place, he pegs it down slightly with "double-broaches," which are cleft twigs about two feet long and half an inch thick, sharpened at both ends, bent double and notched, so as to clasp the straw on the ridge. This done, the thatcher lays a coat of straight straw six or eight inches thick across the ridge, beginning on either side at the uppermost butts of the reeds, and finishing with straight handsful evenly across the top of the ridge. Having laid a length of about four feet in this manner, he proceeds to fasten it firmly down, so as to render it proof against wind and rain; this is done by laying a "broachen-ligger" (a quarter-cleft rod, half an inch thick and four feet long) along the middle of the ridge, pegging it down at every four inches with a double-broach, which is first thrust down with the hands, and afterwards driven with the legget or with a mallet. The middle ligger being firmly laid, the thatcher smooths down the straw with a rake and his hands, about eight or nine inches on one side; and at six inches from the first, he lays down another ligger, and pegs it down with a similar number of double-broaches, thus proceeding to smooth the straw and to fasten on liggers at every six inches, until he reaches the bottom of the cap. One side being thus finished, the other is similarly treated; and the first length being completed, others are done in like manner, till the farther end of the ridge is reached. He then cuts off the tails of the straw neatly with a pair of shears, level with the uppermost butts of the reed.

When straw or heather is used for thatching, the material is laid on in parallel rows, much the same as the reeds, but the mode of fastening is generally somewhat different.

Chapter V.

THE WOOD-WORK. GROWTH AND TRANSPORT OF TIMBER.

The operations of the carpenter and joiner in the preparation of the wood-work of a house are quite as important as those of the mason or bricklayer. It would not be possible in this little volume to trace clearly all the different processes connected with the building of a house as they occur in practice; for the bricklayer and the carpenter combine their work, as it were, step by step. But as the bricklaying and the slating, or tiling, relate principally to the exterior of the house, and the carpentry work to the interior, we have thus a line of separation, which will greatly contribute to the clearness of these details.

As on a former occasion we noticed the operations of the quarry, whence the builder is supplied with stone, slate, &c., it will now be interesting to give a few details respecting the growth and transport of timber.

The Oak as a Timber Tree.

It is obvious that in every country native timber is preferred, provided it can be obtained in sufficient quantity at a cheap rate; if not, it is imported from other countries. In Britain, the first and most important of all trees is, of course, our own oak, of which we have two species and several varieties, belonging to the genus *Quercus*.

The two species of oak natives of Britain, though greatly resembling each other in general appearance, may yet very readily be distinguished, when once their specific characters are pointed out. As these two species are very commonly confounded together, and as one of them is believed to afford a far more valuable timber than the other, it may be useful to note their difference, and exhibit the characters by which each may be known.

The true British oak, *Quercus robur*, (fig. 1) bears its acorns on a stalk, or *peduncle* (fig. 1, A), and hence it is sometimes called *Quercus pedunculata*, but its leaves grow close to the stem, without a footstalk, or at least with a very short one. In the other native species (fig. 2), these two characters are reversed: the leaves grow upon a footstalk, while the acorns are produced *sessile*, that is, sitting close to the stem (fig. 2, A); from which latter character this species has acquired the name of *Quercus sessiliflora*.

The above characters will, for the most part, be found

pretty constant. At the same time, it may be remarked, that the oak is a tree subject to great variations; and accordingly individuals of each species occasionally occur, which in their characters are found more or less to approach those of the

other. *Quercus robur*, for example, sometimes bears its acorns almost close to the stem, and sometimes *Quercus sessiliflora* will bear them on a short footstalk. The leaves, too, of each, frequently vary in the length of the *petiole*, or

leafstalk. But in a general way (as already stated), each kind may be readily distinguished by the above obvious points of difference.

Both species are common in Britain, though *Quercus sessiliflora* appears to be not so generally distributed as the other; in many districts its growth seems to be principally confined to woods and coppices, where it sometimes occurs even in greater abundance than the common species. *Quercus robur* is believed to afford the more valuable timber of the two, owing, probably, to its being of slower growth. It is doubtful, however, whether the respective merits of each, in point of durability of timber, have yet been fairly put to the test. Where oak is grown in coppices, to be cut down periodically for poles, *Quercus sessiliflora* is at least a valuable, perhaps a preferable tree, on account of its more rapid and cleaner growth.

No certain specific characters, we are aware, can be derived from the mere size or shape of the acorns, or of the leaves. It may be mentioned, however, as a general, though not a constant rule, that *Quercus sessiliflora* usually bears very small acorns, and that its leaves are, for the most part, larger, and more regularly laciniated or notched, and consequently handsomer, as *individual leaves*, than those of *Quercus robur*. The foliage of the latter species, however, taken as a whole. is by far the more beautiful; its leaves, being smaller, and growing close to the stem, and not on footstalks, combine better, form more dense and compact masses, and exhibit to greater perfection those exquisite tufts, or rosettes, which constitute one of the peculiar charms of oak foliage.

The oak is far less used in civil architecture than formerly, although there are certain purposes in building to which it is still applied; but owing to its value and the demand for it for ships, and to the great labour required to work it, its place is now supplied by *fir*. The best oak is that which grows on cold, stiff, clayey soils, and is the slowest in arriving at maturity; and the colder the climate, or the higher above the level of the sea the tree grows, provided it be not stunted from severity of climate, the better the timber: hence Scottish and Welsh oak is more esteemed than that from the middle or southern counties of Britain. Our own island does not produce this timber in sufficient abundance to supply the demand, and large quantities of oak are imported from different countries, especially from Prussia and Canada. There are four kinds of oak used in the Royal Dock-yards,—Welsh, Sussex, Adriatic, and Baltic,—besides two others, termed African oak, employed in different parts of the vessels, according to the qualities requisite for the particular purpose.

Next to our own oak, that from the shores of the Baltic is by far the most esteemed.

In domestic architecture, oak is only used in the largest and best buildings, occasionally for the principal beams; but its chief use is for door and window frames, sills, sleepers, king-posts of roofs, for trussing fir girders, for sashes, for gates of locks, sluices, posts, piles, &c. The timber called *African oak*, used in the navy, is wood of a different genus.

Wainscot is the wood of a species of oak, imported from Russia and Prussia in a particular form of log.

Teak is the produce of a tree of the genus *Tectona. T. grandis* is one of the largest Indian trees, and one of the most valuable, on account of its excellent timber. The trunk is neat, lofty, and of an enormous size; the leaves about twenty inches long and a foot or more wide; the flowers small, white, and fragrant, and collected into very large panicles. It is a native of various parts of India, and was introduced into Bengal by Lord Cornwallis and Colonel Kydd. The wood of this tree has been proved by long experience to be the most useful timber in Asia; it is light and easily worked, and at the same time strong and durable. It is considered equal to oak for ship-building, and has some resemblance to it in its timber; many vessels trading between this country and India are constructed of it. That which grows near the banks of the Godavery is beautifully veined, closer in the grain, and heavier than other varieties. "On the banks of the river Irrawaddy, in the Birman empire, the teak forests are unrivalled; and they rise so far over the jungle or brushwood, by which tropical forests are rendered impenetrable, that they seem almost as if one forest were raised on gigantic poles over the top of another. The teak has not the broad strength of the oak, the cedar, and some other trees; but there is a grace in its form which they do not possess." A specimen of this tree was introduced into the Royal Gardens at Kew about seventy years ago; but from the coldness of our climate it can never become a forest-tree in this country.

Valuable as teak is found to be in ship-building, it has not yet been used in domestic building to any extent. From sixteen to eighteen thousand loads of teak are annually imported into Britain from India, principally for the Royal Dock-yards, this wood being used for certain beams and pillars in ships.

The Fir and Pine as Timber Trees.

Fir, or *Pine*, ranks next to oak for its valuable qualities, and if its universal application be taken into consideration, it

might be thought even superior in importance. It is used for every part of houses, and extensively in ship-building, in the fittings-up, while it constitutes the only material for masts, for which purpose its lightness, and the great length and straightness of the trunk, peculiarly fit it.

Pine, or fir, is imported into this kingdom under the various names of timber, battens, deals, laths, masts, yards, and spars, according to the size or form into which the tree is sawed. It is called *timber* when the tree is only squared into a straight beam of the length of the trunk, and from not less than eight or nine inches square, up to sixteen or eighteen square; fifty cubic feet is a load of timber. Deals vary in length and thickness from eight to sixteen feet, eleven inches wide, and from one and a half to three and a half inches thick. Four hundred superficial feet of one and a half inch plank make a load. *Battens* are small long pieces of fir about three inches wide and one inch thick. Masts, yards, and spars, are the trunks of small trees simply barked and topped.

The pine is, generally speaking, an evergreen, and the wood becomes harder and more durable when the situation is cold, and also when the growth of the tree is slow. Norway, Sweden, the shores of the Baltic, and Canada, are the chief localities of the forests of pine. England is supplied principally from Canada, not because the timber from that country is better than that derived from the north of Europe, but because our timber duties fall heavily on the European pine, the object of the legislature being to encourage the importation of pine from our North American colonies.

Almost the whole of what is now called Canada was once an immense pine forest. With respect to the Baltic region, Dr. Clarke said, that if we take up a map of Sweden, and imagine the Gulf of Bothnia to be surrounded by one contiguous unbroken forest, as ancient as the world, consisting principally of pine trees, with a few mingling birch and juniper trees, we shall have a general and tolerably correct notion of the real appearance of the country. The same writer observed, that the King of Sweden might travel from sunrise to sunset through some parts of his territories, without meeting any other of his subjects than pine trees.

The Norway Spruce Fir.

The species of Spruce Fir (*Pinus abies*), represented in the engraving, has been known as a British tree for more than three hundred years, but Norway seems, as far as it can be ascertained, to be its native country. It differs from the

The Norway Spruce Fir.

Scotch fir in general appearance, as well as in the structure of its leaves and cones. The beautiful feathery appearance of its foliage is very striking, but the extreme regularity of its form rather detracts from the beauty of a landscape when it is too often repeated; it is easily known by its long pendulous cones, as well as by its formal shape. The spruce fir is found in great abundance in all the Norwegian forests; it is

also spread over the whole of the north of Europe. and part of Asia, and it occurs on most of the mountain-ranges of both these quarters of the globe; in favourable situations it attains a great height, as much at times as 150 feet.

The spruce grows more rapidly than any other of the fir tribes; its wood is extremely tough and strong, and answers well for masts and spars, but it is not so valuable when cut into planks as that of other species. It does not attain the same size in Britain as in colder climates, the tree perhaps being weakened by the loss of its sap, which in hot weather is discharged through the bark in considerable quantities. The more protracted season of growth, and the greater difference between the temperature of the day and the night, must have an effect upon it, and judging from the situations which it prefers on the Continent, the summer rains of England cannot be by any means favourable. The almost continual day in the Polar countries, while vegetation is active, produces a uniformity of temperature, and a consequent uninterrupted growth dav and night, while in countries farther south, the vegetable action is checked every night, and renewed again every morning, especially in the early part of the season, when such alternations are most dangerous.

1 1 Male Catkins, or Blossoms.
2 2 2 Cones containing the Seed.

The Norway Spruce is called by the French the Pitch Spruce, from its yielding the Burgundy Pitch of commerce. To obtain this, parts of the bark are removed in the spring, and the resin exudes in greater or smaller quantities, according to the state of the tree; this is scraped off from time to time. After a sufficient quantity has been collected, it is melted in hot water, and strained through bags to separate the impurities. If the strips of bark which are removed are narrow, the trees will continue to yield for several years.

The Norway Spruce, and all other trees of the fir tribe, are propagated by means of seeds. These are to be sown rather thinly about the middle of March, in a shady well-sheltered border; towards the autumn the ground is to be carefully weeded, and a quantity of rich earth strewed lightly over the whole. During the winter, if the frosts are very severe, the young plants ought at times to be protected from the severity of the weather. In the next spring, and during the months of May and June, the young plants will be much assisted by frequent waterings, and in the autumn the ground must be again cleaned. In the succeeding spring, when their heads begin to swell, they may be removed. At four years old they may be transplanted again to a spot of good land, and placed in rows two and a half feet asunder, and fourteen or sixteen inches distant in each row. Three years after they will again require to be transplanted four feet asunder, and so on, increasing the space between the trees at each remove, until the young ones are fourteen or sixteen feet in height.

The Scotch Fir.

One of the most useful kinds of pine is the *Pinus Sylvestris* (wild pine), generally known as Scotch fir. It is this tree which produces that kind of wood so extensively useful to the carpenter under the name of *deal*. The term "deal" implies timber squared into a convenient size for exportation, and it is in the form of deals that the wood of which we are now speaking is imported into England from Norway and the Baltic. The best part of this wood is near the root; and the roots themselves are valuable for many purposes. It is of this wood that the bodies of violins and the sounding boards of musical instruments generally, are made: the grain of the wood formed by the annual layers being very straight and regular. In trees which have not arrived at maturity, there is a portion of sap-wood next the bark; this sap-wood is converted into ligneous matter in about two or three years from its formation.

The Scotch Fir.

The Scotch Fir, or Pine, is not peculiar to Scotland, but is common to all the mountain-ranges of Europe; in low damp situations it never thrives, but delights in the exposed summits of the loftiest rocks, over which the earth is but thinly scattered: there its roots wander afar in the wildest reticulation, whilst its tall, furrowed, and often gracefully-sweeping, red and gray trunk, of enormous circumference, rears aloft its high umbrageous canopy.

The fir was a very great favourite with Gilpin, who considered it, as it really is, to be under favourable circumstances, a very picturesque object in a landscape: the earnestness with which he defends its character is peculiarly forcible; he says, "It is a hardy plant, and, therefore, put to every servile office. If you wish to screen your house from the south-west wind, plant Scotch firs, and plant them close and thick. If you want to shelter a nursery of young trees, plant Scotch firs, and the phrase is, you may afterwards weed them out at your pleasure. This is ignominious. I wish not to rob society of these hardy services from the Scotch fir, nor do I mean to set it in competition with many trees of the forest, which, in their infant state, it is accustomed to shelter; all I mean is, to rescue it from the disgrace of being thought fit for nothing else, and to establish its character as a picturesque tree. For myself, I admire its foliage, both the colour of its leaf and its mode of growth. Its ramification, too, is irregular and beautiful."

The practice of planting this tree in groups is the cause to which its unfavourable character, as a picturesque object, may be attributed, the closeness of growth causing the stems to run upward without lateral branches. The hilly regions of the whole of Great Britain and Ireland were formerly covered with vast forests, a great portion of which consisted of fir-trees. Of these ancient forests some remains still exist; in Scotland, the relics of the Rannock forest, on the borders of the counties of Perth, Inverness, and Argyle, are well known: these consist of the roots and a few scattered trees, which are still found in situations of difficult access. This forest appears to have stretched across the country, and to have been connected with the woody districts of the west of Scotland. The Abernethy forest, in Perthshire, still furnishes a considerable quantity of timber.

"At one time," we quote Sir Thomas Dick Lauder, Bart., "the demand for it was so trifling, that the Laird of Grant got only twenty pence for what one man could cut and manufacture in a year. In 1730 a branch of the York Buildings Company purchased seven thousand pounds' worth of timber, and by their improved mode of working it, by saw-mills, &c., and their new methods of transporting it in floats to the sea, they introduced the rapid manufacture and removal of it, which afterwards took place throughout the whole of the sylvan districts. About the year 1786 the Duke of Gordon sold his Glenmore forest to an English company for 10,000*l*. This was supposed to be the finest fir-wood in Scotland. Numerous trading vessels, some of them above five hundred tons burden, were built from the timber of this forest, and

one frigate, which was called the Glenmore. Many of the trees felled measured eighteen and twenty feet in girth, and there is still preserved at Gordon Castle a plank nearly six feet in breadth, which was presented to the Duke by the Company. But the Rothiemurchus forest was the most extensive of any in that part of the country; it consisted of about sixteen square miles. Alas! we must indeed say, it *was*, for the high price of timber hastened its destruction. It went on for many years, however, to make large returns to the proprietor, the profit being sometimes 20,000*l.* a year."

Besides the forest we have mentioned, there are still in existence other tracts of land in different parts of Scotland covered with this timber. The attention which has been drawn to the value of the Scotch fir has been an inducement to proprietors of land to cause extensive plantations to be

Leaves and Male Blossom of Scotch Fir.

Cone of Scotch Fir.

formed on suitable spots; but Nature herself takes measures to perpetuate her work where the hand of man has carried destruction; for, after the old trees have been felled and carried off the ground, young seedlings come up as thick as in the nurseryman's seed bed.

The timber supplied by the Scotch fir is called Red Deal, and the uses to which it is applied render it necessary that the stem should be straight, and close planting materially assists in this object, by preventing the possibility of the trees flinging out their lateral branches; this, as we have already noticed, disfigures the tree in the eye of an artist, however

much it may delight that of a timber merchant. The straightest and cleanest-grown trees are selected for masts, spars, scaffold-poles, &c., while the largest *sticks* are sawed into planks for various purposes. Its wood is very durable, and resists the action of water excellently. The persons employed at different times in the endeavour to rescue the cargo of the Royal George, which foundered off Spithead, in the year 1782, discovered that the fir-planks had suffered little, if any injury, while the other timbers of the vessel had been much acted upon by the water and different species of worms.

In Holland this tree has been used for the purpose of preparing the foundations of houses in their swampy soil; 13,659 great masts of this timber were driven into the ground for the purpose of forming the foundation of the Stadthouse at Amsterdam. But it is not only for its timber that we are indebted to this tree; those useful articles, tar, pitch, and turpentine, are all yielded by its sap.

Transport of Timber from the Forests.

Probably but few of our readers think of the means by which *timber* is conveyed from the forest where it grows, to the spots where it is to be applied to the purposes of building. And yet it must be evident that the means of transport form a matter of no small importance. We know that our timber-yards are plentifully supplied with the various kinds of wood necessary for building; and that the timbers are shaped by the axe and the saw. But, in most cases, the wood which we employ is brought from foreign countries, often many miles inland. It is conveyed across the ocean in ships; but the mode of transporting it from the forests where it grows to the ports where it is to be shipped, is a curious subject, and one well worthy of a little attention.

The main circumstance that forms the groundwork of all the plans adopted for this purpose is, that nearly all kinds of wood are, bulk for bulk, lighter than water, and will consequently swim on its surface. Now as all countries are, more or less intersected by rivers, which flow from the interior into the sea, a very simple and economical mode of transport for timber is at once attained, by causing it to float down running streams, either by the mere force of the descending water, or by the aid of mechanical agents. There is no necessity that each piece of wood should be floated separately down the stream; for they may be fastened together and steered down the middle of the river, in the form of a long and broad raft.

Beckmann says: "It is probable that the most ancient mode of constructing vessels for the purpose of navigation, gave rise to the first idea of conveying timber in the like manner; for the earliest ships or boats were nothing else than rafts, or a collection of beams and planks bound together, over which were placed deals. By the Greeks they were called *schedai*, and by the Latins *rates;* and it is known, from the testimony of many writers, that the ancients ventured out to sea with them, on piratical expeditions, as well as to carry on commerce; and that after the invention of ships, they were still retained for the transportation of soldiers, and of heavy burdens."

There are some passages in the Bible which allude to the floating of wood. 1 Kings v. 9: "My servants shall bring them down from Lebanon unto the sea; and I will convey them by sea in floats unto the place that thou shalt appoint me." 2 Chron. ii. 16: "And we will cut wood out of Lebanon, as much as thou shalt need: and we will bring it to thee in floats by sea to Joppa, and thou shalt carry it up to Jerusalem." These passages relate to a compact between Solomon and Hiram, king of Tyre, by which the latter was to cause cedars for the building of the Temple to be cut down on the western side of Mount Lebanon, above Tripoli, and to be floated to Jaffa or Joppa, probably along by the sea shore.

The Romans transported by water both timber for building and fire-wood. When, during their wars against the Germans, they became acquainted with the qualities of the common *larch*, they caused large quantities of it to be carried on the river Po, to Ravenna, from the Alps, particularly the Rhætian, and to be conveyed also to Rome, for their most important buildings. Vitruvius says, that this timber was so heavy that the waters could not support it, and that it was necessary to carry it in ships or on rafts. Could it have been brought to Rome conveniently, says he, it might have been used with great advantage in building. It has also been supposed that the Romans procured fire-wood from Africa, and that it was brought partly in ships and partly on rafts.

But it is in Germany that the transportation of timber by means of floats has been most extensively carried on, partly on account of its noble forests, and partly through the possession of the river Rhine. There is evidence of the floating of timber-rafts in Germany so far back as the year 1410. A letter from the Landgrave of Thuringia says, that on account of the scarcity of wood that existed in their territory, the landgraves had so far lessened the toll usually paid on the river Sale as far as Weissenfels, that a Rhenish florin only

was demanded for *floats* brought on that river to Jena, and two Rhenish stivers for those carried to Weissenfels; but the proprietors of the floats were bound to be answerable for any injury occasioned to the bridges.

In 1438, Hans Munzer, an opulent citizen of Freyberg, with the assistance of the then burgomasters, put a float of wood upon the river Mulda, which runs past the city, in order that it might be conveyed thither for the use of the inhabitants: this seems to imply that such a practice was not then uncommon. When the town of Aschersleben was adorned with a new church, in 1495, the timber used for its construction was transported on the Elbe, from Dresden to Acken, and from thence on the Achse to the place of its destination. In the year 1564, there was a float-master in Saxony, who was obliged to give security to the amount of four hundred florins; so that at that time the business of floating must have been of considerable importance.

When the citizens of Paris had used all the timber growing near the city, the enormous expense of land carriage led to the suggestion of an improved mode of transport. John Rouvel, a citizen and merchant, in the year 1549, proposed to transport timber, bound together, along rivers which were not navigable for large vessels. With this view he made choice of the forests in the woody district of Morvant, which belonged to the government of Nivernois; and as several small streams and rivulets had their sources there, he endeavoured to convey into them as much water as possible. This great undertaking, at first laughed at, was completed by his successor, René Arnoul, in 1566. The wood was thrown into the water in single trunks, and suffered to be driven in that manner by the current to Crevant, a small town on the river Yonne; where each timber-merchant drew out his own, which he had previously marked, and after it was dry, formed it into floats that were transported from the Yonne to the Seine, and thence to the capital. By this method large quantities of timber were conveyed to the populous towns.

A similar mode of transporting timber from the central parts of Germany to the great towns or to the seaports is practised at the present day. Mr. Planché, in his *Descent of the Danube*, says: "Below this bridge, (at Plattling on the Danube,) the raft-masters of Munich, who leave that city every Monday for Vienna, unite their rafts before they enter the Danube. They descend the Isar upon single rafts only; but upon reaching this point, they lash them together in pairs, and in fleets of three, four, or six pairs, they set out for Vienna. A voyage is made pleasantly enough upon these floating islands, as they have all the *agrémens*, without the

confinement of a boat. A very respectable promenade can be made from one end to the other, and two or three huts erected upon them afford shelter in bad weather, and repose at night."

But the anonymous author of *An Autumn near the Rhine* gives a more detailed account of the timber-rafts of Germany, of which we will avail ourselves. A little below Andernach, on the banks of the Rhine, the small village of Namedy appears on the left bank, under a wooded mountain. The Rhine here forms a little bay, where the pilots are accustomed to unite together the lesser rafts of timber, floated down the tributary rivers into the Rhine, and to construct enormous floats, which are navigated to Dordrecht and sold. These machines have the appearance of a floating village, composed of twelve or fifteen huts, on a large platform of oak and deal timber. They are frequently eight or nine hundred feet long, and sixty or seventy in breadth. The rowers and workmen sometimes amount to seven or eight hundred, superintended by pilots and a proprietor, whose habitation is superior in size and elegance to the rest. The raft is composed of several layers of trees, placed one on the other, and tied together. A large raft draws not less than six or seven feet water. Several smaller ones are attached to it, by way of protection, besides a string of boats, loaded with anchors and cables, and used for the purpose of sounding the river, and going on shore. The domestic economy of an East Indiaman is hardly more complete. Poultry, pigs, and other animals, are to be found on board, and several butchers are attached to the suite. A well-supplied boiler is at work night and day in the kitchen. The dinner hour is announced by a basket stuck on a pole, at which signal the pilot gives the word of command, and the workmen run from their quarters to receive their allowances.

The consumption of provisions in the voyage to Holland is almost incredible, sometimes amounting to forty or fifty thousand pounds of bread, eighteen or twenty thousand pounds of fresh meat, a considerable quantity of salt meat, and butter, vegetables, &c., in proportion. The expenses are so great, that a capital of three or four hundred thousand florins is considered necessary to undertake a raft. Their navigation is a matter of considerable skill, owing to the abrupt windings, the rocks and shallows of the river; and some years ago the secret was thought to be monopolized by a boatman of Rudesheim and his son.

The timber of the spruce firs which grow on the sides of the Alps, is considered much finer than that which is produced in other situations; but the inaccessible nature of these

Alpine forests long prevented these useful trees from being sent in any great quantity to the market. During our long continental war, however, a bold and skilful plan was invented, by which this timber was procured in abundance. M. Rupp, an enterprising foreigner, constructed an immense inclined plane of wood on the sides of Mount Pilatus, near the Lake Lucerne; its length was eight miles and a half. Twenty-five thousand large pine trees were employed in its construction. These were barked and put together very ingeniously, without the aid of iron. It occupied one hundred and sixty workmen during eighteen months, and cost nearly a hundred thousand francs, or 4250*l.* sterling. It was completed in the year 1812.

The following description of the slide appeared in a German periodical shortly after its completion:—"This slide has the form of a trough, about six feet broad and from three to six feet deep. Its bottom is formed of three trees, the middle one of which has a groove cut out in the direction of its length, for receiving small rills of water, which are conducted into it from various places, for the purpose of diminishing the friction. The whole of the slide is sustained by about two thousand supports; and in many places it is attached, in a very ingenious manner, to the rugged precipices of granite.

"The direction of the slide is sometimes straight, and sometimes zig-zag, with an inclination of from 10° to 18°. It is often carried along the sides of hills and the flanks of precipitous rocks, and sometimes passes over their summits. Occasionally it goes under ground, and at other times it is conducted over the deep gorges by scaffoldings one hundred and twenty feet in height.

"The boldness which characterizes this work, the sagacity and skill displayed in all its arrangements, have excited the wonder of every person who has seen it. Before any step could be taken in its erection, it was necessary to cut several thousand trees to obtain a passage through the impenetrable thickets. All these difficulties, however, were surmounted, and the engineer had at last the satisfaction of seeing the trees descend from the mountain with the rapidity of lightning. The larger pines, which were about a hundred feet long, and ten inches thick at their smaller extremity, ran through the space of *three leagues*, or nearly *nine miles, in two minutes and a half*, and during their descent, they appeared to be only a few feet in length. The arrangements for this part of the operation were extremely simple. From the lower end of the slide to the upper end, where the trees were introduced, workmen were posted at regular distances, and as soon as everything was ready, the workman at the lower end

of the slide cried out to the one above him, '*Lachez*' (Let go.) The cry was repeated from one to another, and reached the top of the slide in *three* minutes. The workman at the top of the slide then cried out to the one below him, '*Il vient*' (It comes), and the tree was instantly launched down the slide, preceded by the cry which was repeated from post to post. As soon as the tree had reached the bottom, and plunged into the lake, the cry of *Lachez* was repeated as before, and a new tree was launched in a similar manner. By these means a tree descended every five or six minutes, provided no accident happened to the slide, which sometimes took place, but which was instantly repaired when it did.

"In order to show the enormous force which the trees acquired from the great velocity of their descent, M. Rupp made arrangements for causing some of the trees to spring from the slide. They penetrated by their thickest extremities no less than from eighteen to twenty-four feet into the earth; and one of the trees having by accident struck against another, it instantly cleft it through its whole length, as if it had been struck by lightning.

"After the trees had descended the slide, they were collected into rafts upon the lake, and conducted to Lucerne. From thence they descended the Reuss, then the Aar to near Brugg, afterwards to Waldshut by the Rhine, then to Basle, and even to the sea when it was necessary.

"It is to be regretted that this magnificent structure no longer exists, and that scarcely a trace of it is to be seen upon the flanks of Mount Pilatus. Political circumstances having taken away the principal source of demand for the timber, and no other market having been found, the operation of cutting and transporting the trees necessarily ceased."*

Professor Playfair, who visited this singular work, states, that six minutes was the usual time occupied in the descent of a tree; but that in wet weather, it reached the lake in three minutes. He found it quite impossible to give two successive strokes of his stick to any, even the largest tree, as it passed him. The logs entered the lake with such force, that many of them seemed to penetrate its waters to the very bottom. Much of the timber of Mount Pilatus was thus brought to market; but the expense attending the process rendered it impossible for the speculator to undersell the Baltic merchant, when peace had opened a market for his timber, and so the Slide of Alpnach fell to ruin.

* The Mines of Bolanos, in Mexico, are supplied with timber from the adjacent mountains by a slide similar to that of Alpnach. It was constructed by M. Floresi, a gentleman well acquainted with Switzerland.

Cutting the Norway Deals.

When the timber is squared before it is exported, it is effected by saw-mills; the manner of proceeding may be illustrated by the treatment of Norway deals. In some cases, the trees are merely roughly-shaped with the axe; but those which are to be made into deals are floated down the mountain-streams to a spot where many collect together, and where a saw-mill is erected. Dr. Clarke thus speaks of one that he visited:—"The remarkable situation of the sawing-mills, by the different cataracts, are among the most extraordinary sights a traveller meets with. The mill here was as rude and picturesque an object as it is possible to imagine; it was built with the unplaned trunks of large fir-trees, as if brought down and heaped together by the force of the river. The saws are fixed in sets parallel to each other, the spaces between them in each set being adapted to the intended thickness for the planks. A whole tree is thus divided into planks, by a simultaneous operation, in the same time that a single plank would be cut by one of the saws. We found that ten planks, each ten feet in length, were sawed in five minutes, one set of saws working through two feet of timber in a single minute." The deals are afterwards transported by river or canal to seaports.

The Cutting and Transport of Canadian Timber.

The conveyance of timber to market in Canada is a very remarkable instance of commercial enterprise. While standing in the vast pine forests the timber-trees are common property: they acquire money-value only when the axe has been applied to them, and when they have been brought down to a shipping port.

The words *lumber* and *lumbering*, which convey no very definite idea to us, have in Canada and the United States a large and important meaning. *Lumber* is the general name for all kinds of timber, not only while growing in the form of stately trees, but after it is cut down, and even after it has been rudely fashioned into such pieces as may be convenient for shipment. So, in like measure, *lumbering* may be taken as a general name for all the operations whereby the timber is brought into a marketable state; including the cutting down of the trees; the conveyance to the saw-mills; the sawing them into boards, planks, joists, and other pieces; the forming them into rafts: and the navigating of these rafts down the creeks and rivers to the seaports. All the persons

employed in these operations are designated *lumberers;* and they are subdivided into smaller groups according to the duties they undertake to perform.

As the practice of lumbering has been carried on for a great number of years, all the forests in the vicinity of seaports have been denuded of their trees: and the lumberers have therefore to go far inland to obtain their supply of timber. This occasions one circle of operations to last an entire year, from summer to summer. As the lumberers who dwell in the interior frequently carry on some other occupation, perhaps an agricultural one, they cut down trees in the forest just as it suits their convenience, during the summer and autumn. These trees are either hewn and shaped into balks and beams, or divided into shorter pieces, according as they are to be exported whole, or sawed up into boards and scantlings for the American or Canadian markets.

When a large supply of timber has been thus cut down, and the winter is so far advanced that snow lies on the ground, preparations are made for conveying the timber to some stream or river which flows down to a commercial port. On the banks of such streams saw-mills worked by water-power are erected, and these are employed for cutting up such of the "lumber" as is to be sold in the form of planks. The conveyance to the saw-mills and the operation of sawing occupy together the entire winter season. When snow is on the ground, a stout pair of oxen can drag a log from the forest to the saw-mill; and this method of transport is almost universally adopted, very few horses being employed in this way. Sometimes the saw-mills are constructed in a small creek near the forest, but in other cases they are lower down, on the banks of larger streams; and in this latter case the logs are floated down the smaller streams till they arrive at the larger one, where a dam or barrier is placed across the stream to prevent them from floating beyond the precincts of the saw-mill. The saws are circular in shape. Many of the mills have but one saw in operation; others have groups of parallel saws capable of cutting the log into eight or ten planks at once. Some of the smaller mills are built in so rude and rough a manner, that their cost does not exceed 30*l.* or 40*l.*; but if the mill lasts as long as the supply of timber in the neighbourhood, that is deemed sufficient, and a new mill is built when it is found advantageous to shift the quarters farther inland. A small mill with one saw, worked for twenty-four hours, will cut up three or four thousand superficial feet of timber. Men are employed to roll the logs along the gangways to a platform, and place them in a proper position to be acted on by the saw.

During the season of these operations the rivers and streams are frozen up; but in spring, when the melting of the ice renders them navigable, preparations are made for transporting the timber from the mills to the shipping ports. If the mill be on the banks of a small stream, the lumberers make up the logs and planks into rafts, the dimensions of which are suited to the capacity of the stream, and when these reach a larger stream into which the smaller one empties itself, the small rafts are broken up and re-arranged into larger ones; but if the mill be on the banks of the larger stream, the timber is at once made up into the rafts which float down to the shipping port—three or four hundred thousand feet of timber being sometimes conveyed in one raft. Sometimes the streams are too small to admit the rafts to float down them: and in such case they often lie aground for months, until an accidental flooding increases the body of water; or else they have to be broken up altogether, and other means adopted for conveying them to market. The rafts are generally put together very slightly, the value of labour being high, and the lumberers regulating the strength of the raft only in proportion to the distance which it has to float. This distance may vary from fifty to three or four hundred miles. Some one of the lumberers who may happen to be best acquainted with the stream acts as pilot, all the others following his directions in the navigation. The raft moves just as fast as the stream will convey it, be it slow or quick, no acceleration of speed being attempted by sails or oars; so that the time which elapses before the raft reaches its destination depends on many different circumstances. In some instances, where all the circumstances are favourable, the pilot navigates his cumbrous raft night and day without stopping; but if there are difficulties, he directs it into some cove or sheltered place during the night. The men are provided with long poles, by which they can regulate the position of the raft in the stream, keeping it either in the middle of the current or near the bank. The men seldom trouble themselves to make huts or cabins on the rafts: for the weather being spring, and it being optional to them to go on shore when they please, they make very few arrangements for their trip except in provisions. On the St. Lawrence, however, where the French Canadians bring down timber-rafts to Quebec for shipment, the men erect small huts or temporary dwellings on the rafts, since the voyage becomes of a more serious character.

When the rafts reach their destination, the lumber is sold, and the men share the proceeds according to the nature of their stake in the enterprise. This share is one entire year's

earnings, and the final disposal of the timber is therefore a matter of importance. The men then set out on foot to return to the interior, and as the distance they have to travel is sometimes three or four hundred miles, and the summer warmth has arrived, the journey is generally a fatiguing one. The men are not all fellow-labourers in an equal degree, for —as in almost every other kind of commercial enterprise— there must be some one to act as a capitalist, to feed the labourers while they are employed, or others who will supply necessaries in advance. There are storekeepers who purchase an annual supply of provisions, clothing, implements, &c., and retail them out to the lumberers on credit, to be paid for when the sales are effected in the spring, and when the mill-owner has been enabled to pay the wages of the men who felled, transported, and sawed the timber. If any unforeseen accident prevents the raft from reaching the shipping port in a saleable state, or if any other mishap occurs, the whole community share the loss.

The lumberers are among the roughest and rudest of the Canadian and American population: for their occupation takes them so little among the haunts of commercial or cultivated men, that they are only a few shades superior to the American Indians—in some points far beneath them.

Miscellaneous kinds of Timber.

Deal so completely takes precedence of all other timber in house-building, that a very slight notice of other varieties will suffice.

Beech is partially employed in ship-building for the keel and timbers near it; but it is not at all employed in civil architecture. The principal use made of this wood is in the construction of machines, mill-work, lock-gates, &c., and for handles to tools; it is also a good wood for the turner, being of a close grain. It will not, however, bear alternations of moisture and dryness, and is liable to be attacked by worms, so that it is not extensively employed.

Chestnut belongs to the same tribe as the beech, but although a valuable wood, it is now little, if ever, used. Formerly it was extensively so, and the roofs of several ancient buildings were constructed of it. From some experiments, indeed, it seems to be as durable as oak itself.

Ash is the wood for the wheelwright and the maker of agricultural implements; it is one of the most valuable of all timber trees, combining great strength with elasticity and lightness; it, however, splits easily. Ash is not used either by the shipwright or the common carpenter.

Elm is a coarse-grained wood, but strong and durable, it does not work readily, and is therefore but little used. It is, however, employed for certain parts of ships, and for making casks, chests, coffins, posts for mill-work, and a few other purposes.

Next to oak and fir, the foreign wood *Mahogany* is by far the most valuable, and that most extensively used; it is the growth of the West Indies and South America, and the tree, the *Swietenia mahogani*, is, perhaps, the most majestic of all timber trees from the enormous dimensions to which its trunk attains, its vast height and size, and its dark beautiful foliage. The mahogany of the island of Cuba, and that from the bay of Honduras, is first in estimation. There are two East Indian species, but they are not imported in any quantities into this country.

The best mahogany is that which grows in dry, cold, and exposed situations. Such wood is fine-grained, hard, and dark in colour, richly variegated, causing it from its beauty to rank among the most ornamental of fancy woods, while the light, coarse-grained wood, which grows in warm moist climates, is sufficiently abundant to be used for ordinary purposes, and yet possesses admirable properties for all, where no great strength or tenacity is wanted.

Within the last twenty years the use of this wood has increased amazingly, and some ships have many of their upper timbers above the water-line constructed of Honduras mahogany. Its use in furniture and cabinet-making is well known, and, indeed, it may be said to be the principal wood used for this purpose, and to have entirely supplanted our own walnut, which was formerly in universal use for the same purposes.

The woods above enumerated are those most extensively or largely used by the carpenter; but there are several others employed for small articles, and for particular purposes, which deserve mentioning.

Box is the wood of the *Buxus sempervirens*, a hardy evergreen plant, indigenous in all the southern parts of Europe and Western Asia, and long domesticated in our shrubberies. Box is especially the wood for turning, it being closer-grained, denser, and tougher than perhaps all others, except *iron-wood*, *Lignum Vitæ*, and one or two rarer woods. Box is used for rules, scales, and for small cabinet works; but that which gives it particular importance is its universal use for wood-engraving.

Lance is the name given to the wood of the *Guatteria virgata*, a tree indigenous to Jamaica, and one of the most important that are so, from the valuable qualities of its tim-

ber, lance-wood far exceeding our ash in lightness, strength, and elasticity; hence it is admirably calculated for shafts to carriages, handles to spears, and for all purposes where straight, light, flexible, and tough wood is required. It is neither so close-grained nor so hard as box, but it turns well, and does not split; in colour, it is lighter than box.

Ebony is the name given to the wood of several different trees, which agree in being dark-coloured, dense, and durable; it is used for inlaying and for making rules or scales, as not being liable to warp. It is an excellent wood for turning; but, except for these purposes, it is less in request now than formerly, when it was much used in cabinet-making.

Lignum Vitæ is the wood of the *Guaiacum officinale*, a large tree indigenous in the West Indies. This wood is the hardest and heaviest known, and can only be worked in the lathe. It is much used for making the *sheaves*, or pulleys of blocks used in shipping, and for friction-rollers, &c.

There are various foreign woods which, from their beautiful grain and varied tints, are used in cabinet-making. But as these woods are too valuable to be used solid, they are sawed into thin leaves, called *veneers*, which are glued down on a backing of ordinary mahogany. The principal of these fancy woods are—

Rose-wood, which is produced by a tree a native of Brazil. This wood is much used for furniture, both as a veneer, and solid for legs of tables, chairs, &c.

King-wood is also the produce of Brazil; it is a dark chocolate wood, veined with fine black veins.

Beef-wood comes from New Holland; is of a pale-red even tint, and intensely hard and heavy. It is used for inlaying and bordering.

Tulip-wood is a wood of a clouded red and yellow colour, and very hard, and used for bordering to larger woods. The tree is unknown to our botanists.

Zebra-wood is a large-sized tree, and abundant enough to be used as a veneer in large furniture, like rose-wood: it is more curious than elegant.

Satin-wood is well known for its glossy yellowish tint, from which it derives its name; there are two varieties.

Maple, from our own indigenous tree, is a very elegant wood, of a light colour, or else, near the root, variegated with knots and twisted grain. It is much used in fancy work.

Chapter VI.

THE WOOD-WORK. CARPENTRY.

Having thus briefly noticed the principal kinds of timber, and some of the modes of bringing it to market, we have in the present chapter to trace the wood through the various processes whereby it becomes part and parcel of a house.

Sawing Timber.

When a timber-tree is felled, the branches, arms, and boughs, are cut off, and the bark stripped, this being valuable for many purposes. The trunk is then sawed square, and again cut into *planks, deals, battens,* &c., as the different-sized boards into which it is reduced are called.

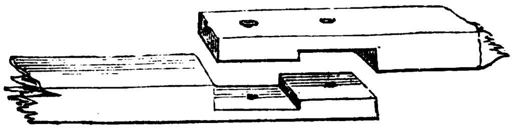
Teak and mahogany are imported into this country in *logs,* distinguished from the long beams known technically as *timber,* by their width and thickness being considerable in proportion to their length.

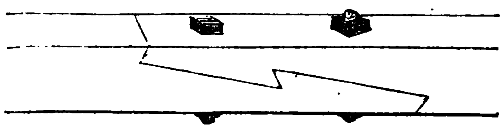
Timber is sawed in countries producing, or using it, in great quantities in saw-mills, in which the tools are worked by water or steam, as described in the last chapter; and it is also sawed into battens, laths, &c., by circular saws, turned by machinery, like a lathe; but when timber is sawed by hand, it is done by two men acting in concert in the following manner:—A pit is generally chosen, round the margin of which a stout frame is laid. The beam to be sawed is laid along the centre of this frame, in the direction of the length of the pit. One man stands on the beam while another is in the pit below him, and each alternately raises or pulls down a large vertical saw, with which the beam is cut lengthwise into planks. Wedges of wood are placed in the fissure as the work proceeds, to keep the cut open, and thus allow the saw to play freely. This is very hard labour, especially to the upper man, who has not only to raise the weight of the saw in the up-stroke, but to guide it correctly along the chalked line on the beam. This man gets higher wages, and is called the *top-sawyer,* a term technically given in jest to any one who is, or fancies himself, of superior importance.

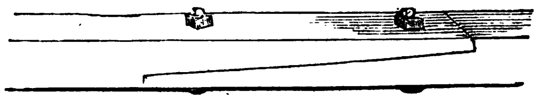
Scarfing or Joining Timber.

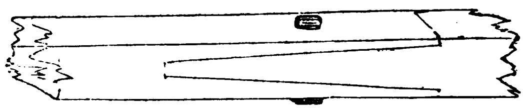
When timber is wanted in lengths exceeding those that can be procured from the tree in one piece, it must be joined by what is called *scarfing;* that is, the ends of the two lengths

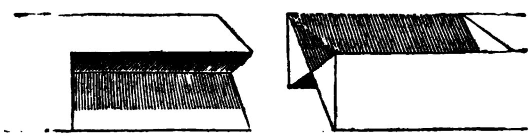
that are to be united into one, are cut so that a portion of the one may lap over and fit into a portion of the other, which is cut so as to receive it. The timber, when united, is thus of the same uniform size. The joined ends are secured together by bolts or spikes. The following figures show the more usual modes of scarfing timber for different purposes.











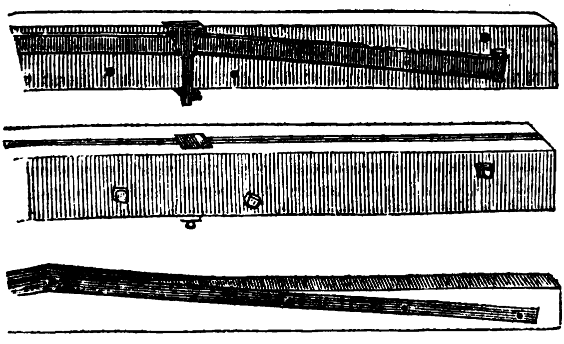
The last is a mode of scarfing invented by Mr. Roberts, of the Royal Dock Yards.

Trussing or Strengthening.

When a beam of timber is long in proportion to its breadth and thickness, it will bend by its own weight, and will be

incapable of supporting much additional load; it may be strengthened by *trussing*, in different modes, of which we will only describe that usually adopted for girders, intended for floors. The beam is sawed longitudinally into two equal beams, each, of course, half the thickness of the original: these halves are reversed, end for end, so that if there were any weak part in the original beam, this may be divided equally between the ends of the compound beam made up of the two halves when bolted together. A flat *truss*, usually of oak, with iron *king-bolts* and abutting plates, resembling in form and principle a timber roof or bridge, is placed between the two half beams, and let into a shallow groove cut in each half to receive it; the compound beam, with this truss in the middle, is then bolted together again by means of iron bolts, with washers and nuts, and consequently becomes rigid by the construction of the truss. The truss is not entirely let into the double beam, as the full effect of strength may be obtained without the necessity for cutting the groove in each half beam of half the thickness of the oak truss; consequently, when the girder is completed, there is a slit all along it, through which the truss is seen lying in its place between the two sides.

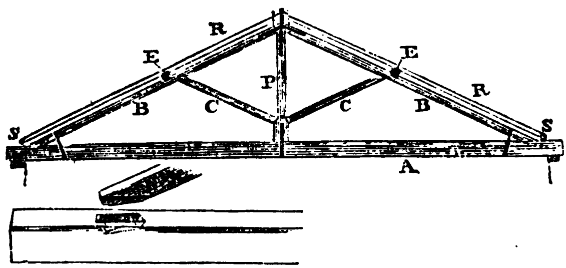
Iron trusses are often used instead of oak, and beams are frequently strengthened by screwing a thin flat iron truss on one or both sides, let into the beam for about half the thickness of the metal.



This mode of strengthening a beam by trussing is only adopted in floors, where it is necessary to limit the depth of the truss to that of the beam, to obtain a level surface by means of joists laid across, and supported by, the beam. But it is obvious that much greater strength may be imparted to a

long beam by making it the base of a triangular frame, as is done in roofs, in various manners, when the slanting sides of the triangular frame carry the battens or laths for supporting the tiles or other covering.

The annexed is the simplest form of a roof, and will help to explain the subject of carpentry in other respects. The beam A, called the *tie-beam*, is of such a length as to rest on the side walls of the house at each of its ends, and is supposed to be of such dimensions in depth and thickness as would render it inadequate to support much more than its own weight. The two sloping rafters B B, are called *principals;* they are *mortised* into the tie-beam at their ends by a joint, shown in the lower figure, by which they are provided with a firm abutment, to prevent the ends from slipping outwards; and in order to prevent the principal from starting upwards out of the mortise, it is strapped down to the tie-beam by an iron strap, bolted or screwed to both timbers.



P is termed a *king-post*, and is cut out with a head and foot, the former to receive the upper ends of the principals, which, being cut square, abut firmly against the sloping face of the head. The sloping principals hold up the king-post, and the tie-beam is supported from the latter by a stirrup-shaped strap, that goes under the beam, and is bolted, or screwed, to the post on each side. To prevent the principals from bending by the strain, or by the weight of the roof covering, the struts C C, are placed, abutting against the bevelled part of the foot of the king-post, and are strapped to the principals, or mortised into them.

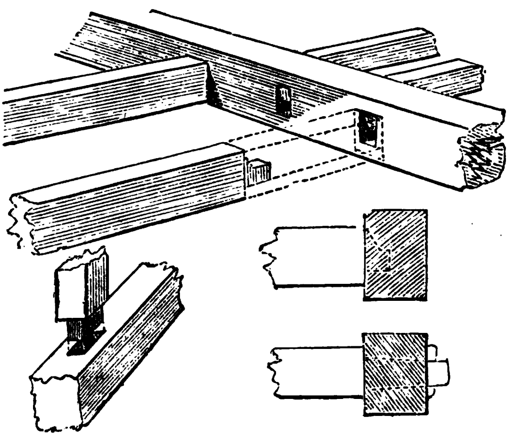
The number of tie-beams, with their trusses, &c., of course depends on the length of the roof, or the material with which it is to be covered. A longitudinal *scantling*, or thin beam, called a *purline*, E, is laid lengthwise, resting on the principals over the ends of the struts, and is secured to the former by a spike, or else by being notched down on to the principal.

These purlines support the common rafters R, which abut at their feet against a longitudinal scantling S, lying on, and *halved* down on, the tie-beams; at their upper ends, the rafters R rest against a *ridge-piece*, or thin plank, let edgeways into the head of the king-post. The rafters are placed about a foot apart, and on to them are nailed the laths or battens to carry the tiles or slates.

The Mortise and other Joints.

In constructing roofs, floors, and other structures of timber, the various beams are *framed*, or fastened together, by certain processes calculated to insure strength and permanence in the framing, which ought to be understood, and their names remembered.

The *Mortise* and *Tenon* joint is used when one beam is to be attached to, and supported by, another, without resting on it, but so that the beams may be in the same plane. The mortise is a hole cut into, or through, the side of the one beam, into which hole the end of the other, cut down to fit the form of the hole, is inserted and fastened. It is obviously necessary to consider two things in determining the size and form of the mortise and tenon. First, that by the former the one beam may not be too much weakened, and yet that it should be large enough to give the tenon that fits into it, sufficient strength to enable the beam to carry the weight intended.

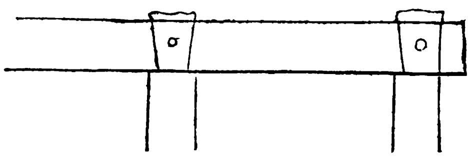


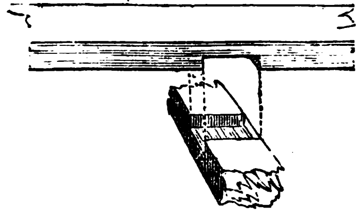
If the one beam is horizontal, and the other to stand perpendicularly upon it, the tenon need only be large enough to retain the upright beam in its place. The foregoing figures are the most usual forms of mortises and tenons, and will explain their use and principle.

It is obvious that two mortises never should come opposite each other on the two sides of the same beam.

When the tenon comes through the beam, it is secured from drawing by a pin or peg put through it.

The *Dovetail* is used to secure one beam into another, when they have to resist any strain acting so as to draw them asunder, rather than to carry any weight; it is consequently employed to frame wall-plates, or the timber laid in walls to carry the ends of beams of floors, roofs, and so on, which plates tend to bind the walls together as well as to receive the ends of the beams. The term is derived from the end of one beam being cut into a shape resembling the spreading tail of a bird, which is pinned down in a corresponding wedge-shaped recess cut in the other beam to receive it. It is clear from this construction that no force, acting in the direction of its length, could pull the first beam out of the second without breaking off the dovetail, which the tenacity of wood-fibre renders nearly impracticable in one of any size. The dovetail is extensively used in all cabinet-making, and may be seen in almost any mahogany or deal-box.





When two beams of equal thickness are required to cross one another and to lie in the same plane, they are *halved* together; that is, a notch is cut in each of half the thick-

ness of the other, then the uncut part of each lies in the notch of the other respectively, and the two are pinned together.

Distinction between Carpentry and Joinery.

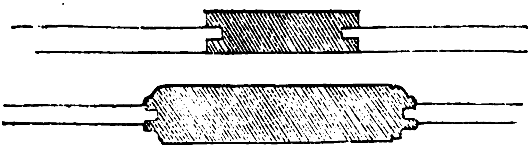
The smaller and better kind of work executed by the carpenter is called *Joiner's work*, such as the making of doors, windows, stairs, wainscotting, boxes, tables, &c. &c., which are usually formed of yellow or Norway deals, wainscot, or mahogany.

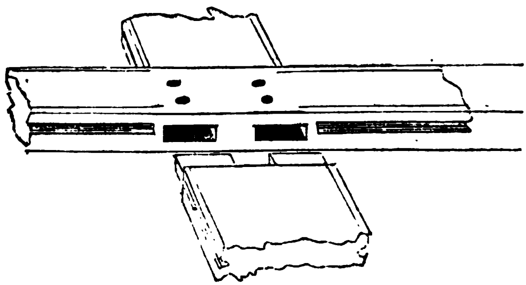
When a large surface is to be of wood, it is not formed of planks fixed together side by side till the requisite width is attained, but it is formed of *framing* and *panelling*. A frame-work of the area required to be covered, is formed of narrow planks, with cross-bars between to strengthen the frame; these are called *stiles* and *rails*, according to the directions in which they run, the former name being given to the upright planks of the frame, while the horizontal ones are called rails.

The rails are mortised into the stiles, and the tenons, since they must be comparatively thin, are made proportionably wide, nearly as wide as the rail. The tenons are always pinned into the mortise holes by one or two wooden pins driven quite through the stiles and through the inclosed tenon.

The edges of the stiles and rails are *ploughed*, that is, a rectangular furrow is cut in the edge by means of a plane, to receive the ends and sides of the *panels*. These panels are formed of thinner deals than the stiles and rails, and are made by glueing the edges of two or more boards together to make the proper width of the panel; the ends and edges of the panel are thinned off to fit into the groove or furrow in the stiles and rails, or else the ends and sides of the panel are *rebated*, that is, worked by a plane into the form shown in the following figure, the projecting part being received into the furrow.

As the panels are thinner than the frame, the former constitute so many recesses, at least on one side of the framing; and a small moulding is glued round the edge of the panel to form a finish to the work. Or else the same object is attained by working the edge of the stiles and rails with such a moulding, so that when the panel is put in, the moulding may finish against it. Sometimes the face of the panel is made to lie in the same plane with the face of the stiles and rails, and the panel is then said to be *flush*, and the edges of





the stiles, &c., are finished with a small bead, also flush with the panel when finished.

In joiner's work the whole surface of the work is made perfectly smooth by *planing* the material, and allowance must be made for the reduction in thickness and width of the wood, produced by this planing, in the choice of the rough material.

The Tools employed.

All mouldings in wood are worked out by planes made of the proper form, to leave the moulding in the wood when the plane has been passed over the part. The carpenter and joiner consequently require a vast variety of planes for these purposes, which constitutes the most expensive part of the expensive tools used by these workmen. These planes receive their names from the form they are intended to produce in the wood, such as *rebating* planes, O G planes, ovolo-planes, beading-planes, and so on.

The next most important tools used by both carpenter and joiner, are *saws*, of different sizes, for reducing the rough wood to the size adapted for the purpose to which it is to be applied. Small, fine-toothed saws, both long and thin blades, termed spring-saws, are used for cutting out small holes in wood, and for analogous purposes, when precision and nicety

are required; these spring-saws are sometimes mounted in a frame on the same principle as that of the stone-mason's saw, formerly described; but commonly, the blade of the saw, of whatever size it may be, is only fixed on a convenient handle, so that the whole blade of the saw may pass through the fissure it makes in the material. All saws are made of the best steel, highly tempered, so as to recover their form if bent by the resistance of the wood.

Next to the planes and saws, *chisels* are the most indispensable tool to the carpenter. These *chisels* are of different widths, adapted to different uses, and are not only used with a hammer or mallet, as the mason employs them, but also as cutting-tools, used by hand for finishing the re-entering angles of mortise-holes, or for finishing the ends of pieces of wood too small to be planed.

The carpenter employs *gimlets* for making holes for screws and nails. The gimlet is a short rod of steel, finished at one end into a sharp-pointed screw of one or two turns only, which, acting on the principle of that mechanical power, compels the tool to sink deeper and deeper into the wood, as the tool is turned round: and to enable the workman to turn the gimlet, it is fixed into a cross handle, which, acting as a lever, allows the friction of the tool to be overcome. Just above the screw point, the rod or shaft of the gimlet is *fluted* or hollowed out: the sharp edges of this fluted part cut the hole made by the screw end larger and smoother, and the hollow receives the chips or shavings cut off, and prevents them from clogging the hole and stopping the progress of the tool.

Augers are large tools shaped like a gimlet, and, acting in the same manner, are employed for making large holes for bolts, spikes, &c. *Centre-bits* are steel tools of different shapes made to fit into a bent handle something like the letter G, which, acting as a lever, allows of the tool being turned round and round by one hand, while by the other the workman holds the top of the handle steady and vertically over the point of the tool. Some of the *bits* or tools are for cutting out cylindrical holes, and are shaped at the cutting-edge like a chisel, with a small point projecting from the centre of the edge, on which the instrument turns in the wood and acts on the principle of a lathe. On each side this point, the chisel-edge is bent sideways in opposite directions, to allow of its *ploughing* up the wood before it with greater efficacy than it would do if it were not so formed.

The *brad-awl*, or *nail-piercer*, is a short steel wire, sharpened at the point into a flat chisel-edge, and put into a

plain turned handle. This edge being pushed into the wood, and the handle turned round, the tool divides the fibre, and makes its way on the simple principle of a wedge, and does not cut away or remove any portion of the material, as the above-described tools do.

The carpenter uses nails and screws to fasten the different parts of his work together, and it is necessary to make a hole to receive them before they are driven in, or else the wood would split by the action of forcing the nail or screw into the solid material, and, indeed, it would be impossible to force a screw into the solid wood at all.

The screw is forced into the wood by being turned round and round by means of a blunt chisel, called a *screw-driver*, the edge of which is inserted into a notch cut in the head of the screw to receive it.

The Glue employed.

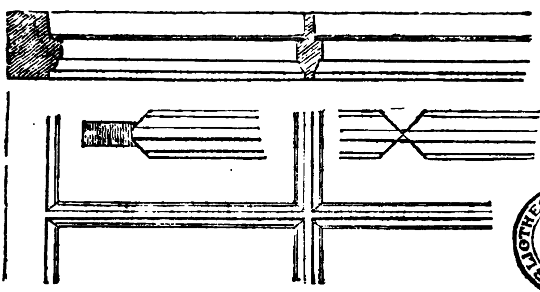
Joiners fasten one piece of their work to another by *glue*, made by boiling down refuse animal matter containing the animal principle called *gelatine* in abundance, such as hoofs, horns, tendons, skin, gristle, &c.: it is a property of gelatine to dissolve in hot water, and to harden again when cold, and the water evaporates. Accordingly the glue, which is only concentrated impure gelatine, is dissolved by heat in a small quantity of water, and being applied to the clean faces of the wood to be united, by a coarse brush, these faces are closely pressed and retained together till the water evaporates, when such is the tenacity of the glue, that the wood may be broken in another place as easily as at the glued joint. To enable glue, however, to act in this manner well, the wood should be clean, the parts to be glued well warmed before the glue is applied, and the joint should be close, or the parts accurately brought together.

Besides the before-mentioned tools and materials, and some others, such as hammers, axes, &c., which need not be described, carpenters and joiners use instruments for measuring and setting out their work, and for drawing on the surface of the material the forms into which it is to be reduced, or the shape and situations of portions of the material to be removed for the purposes of framing. The instruments are compasses, squares, rules, levels, plumb-lines, and so on, common to all artificers who form their materials into geometrical shapes: and, like the mason, the carpenter and joiner must be conversant with the more elementary problems of practical geometry.

A Window-sash, as an example of Joiner's Work.

In illustration of the nature of joiner's work, we may point out the mode of proceeding in making a window-sash, which is one of the most delicate operations of the common joiner. The outer part of the sash is made broader and stronger than the intermediate cross-bars which receive the panes of glass, in order to give strength and rigidity to the sash. This outer part is framed together at the four angles by mortises and tenons, the latter coming quite through the stuff, and having a small sharp wedge driven into the middle of the tenon when inserted into the mortise: by means of this wedge, the tenon is expanded at its end into a wedge-shaped form, by which it fits more tightly into the mortise, and is retained in its place, the wedge-shape not allowing the tenon to be withdrawn again. But it may be here remarked, that, besides this precaution, all small mortises and tenons are put together with glue, to ensure the stability of the joint.

The inner edge of this frame is formed by a *plane* into the half moulding, of which the cross-bars present the entire section, so that when the sash is completed, each panel, as it were, which is filled in with the glass, is surrounded on its sides by a continuous moulding, and on the other side of the frame each panel presents a *rebate* in which the glass lies. The annexed figure of the section of part of the outer frame and one cross-bar, will make this clear.



The cross-bars are made in lengths out of slips of wood, by a plane, which first forms the mouldings and rebate on one side, and then by turning the slip over, the same plane finishes the other with an exact counterpart of the first. These bars are framed into the outer part of the sash by delicate mortises and tenons put together in the manner before described; but it will be seen by reference to the figure,

that the moulded part of the bar must unite to that of the outer frame, or of another bar, by a *mitre*-joint, that is, by one which allows of the lines of mouldings returning on the second piece, at right angles to their direction on the first, without any interruption to the continuity of the surface.

This and all analogous mitre-joints are formed by planing the ends of the wood to form a face, making an angle of 45° with the axis or length of the stuff, and the joiner is provided with a tool called a *mitre-box*, consisting of a stock or frame, in which the stuff being put, resting against one another's surface, guides the plane so as to cut off the end obliquely at the requisite angle. It is clear that this mitre must be made on both faces of the bar, and therefore the two mitre faces form a wedge-shaped termination by meeting at a right angle, as shown in the last figure. Now, as besides the mitre end, a tenon is to be left to fit into a mortise in the outer frame, it is clear that the whole must be a very nice piece of workmanship to be executed on so small a material as the thin bar of a modern sash.

The bevelled mitred end of the bar is received into a corresponding-shaped notch cut the depth of the half moulding in the outer frame to receive it, and at the bottom of this notch is the fine mortise-hole intended to receive the tenon.

The bars of the sash can, of course, only be made in one length in one direction, and the cross-bars which divide the long panels, formed by these continuous bars, into the sizes of the glass, are made of similar short pieces with mitred ends; but these ends, where they frame into the long bars, have no tenon, the thinness of the stuff not admitting of one, since the cross-bars come, end for end, opposite each other, on the two sides of the upright bars.

It is evident that the long bars must be put together with the outside frame, or else the tenons could not be inserted into the mortises made in this last.

A second example of Joiner's Work.

In further explanation of joiner's work, we will briefly describe the mode of making a drawing-board, requiring to be *true*, *plane*, and *square*. Suppose the board is intended to be so wide as to require three boards side by side to make it: these three boards being sawn out of the right length, their edges are first planed perfectly straight and smooth, so that when any two are placed side by side, the edges touching, those edges may touch or fit together accurately for their whole length; this accuracy of joint is obtained by testing the edge after each time the plane is applied, by a straight-

edge, or rule, known to be *true*. There are two modes of proceeding to make these joints firm: one by *dowelling*, that is, by inserting short pieces of hard wood, as oak or wainscot, let for half their length into a mortise cut in the edges of the boards that are to fit together; these mortises, being, of course, made opposite each other, these dowels prevent the boards from rising up or starting from their places when the work is finished. Instead of short dowels, a strip, the whole length of the boards, is let into each joint, half the strip lying in a ploughed groove, made in the middle of the corresponding edges of the two boards. But, besides these precautions, the joints are well glued up.

There are two modes by which this board may be strengthened, to prevent its *warping* or *casting* by the drying or shrinking of the wood. A cross-piece of deal, or better still, of wainscot, is fixed across the ends of the boards, these ends being double rebated or *tongued*, to fit into a groove made in the cross-piece to receive the tongue; these cross-pieces prevent the long boards from warping, since the cross-pieces would have no tendency to alter their figure in the direction of their grain.

If, however, the board be larger, *keying* is better than this clamping. Keying consists in attaching two stout cross-pieces at the back of the boards, the faces of which pieces are worked so as to fit, and are glued into a dovetail-shaped groove cut across the direction of the boards at their back to receive the keys, as will be understood from the annexed sketch.

When the board is made, and the glued joints quite dry, the face is planed perfectly smooth and level, and the edges made truly square, or at right angles; if the board be keyed, the back must be planed smooth before the keys are put in.

The flooring-boards in the better kinds of houses are often *dowelled* in the manner above described, and the ends of the flooring-boards are tongued and grooved to fit together, to prevent the boards from starting up from the joists and becoming uneven.

Beyond this point, it will be not necessary to trace the operations of the carpenter and joiner; for the sawing, scarfing, trussing, and joining large beams for the roof, and the minuter details connected with the window-sash, will illustrate pretty accurately the general nature of the whole routine of processes.

Chapter VII.

THE FIRE-PLACE.

Perhaps no part of the interior fittings of a house is more associated with ideas of cheerfulness and domestic comfort than the *fire-place*. Our abundant supply of coal has probably induced Englishmen to prefer the cheerful fire and the "comfortable fire-side" to any other mode of heating the interior of houses. The steps by which we have arrived at the use of modern grates and stoves, and the question how far these are likely to give way to the methods of warming houses by hot air, by hot water, or by steam, will form an interesting matter for our consideration; and we shall be indebted to Dr. Arnott's treatise on *Warming and Ventilating*, for many illustrative details.

Open Fire-places.

The manner in which rude nations kindle a fire in or near their huts, is one of the most wasteful arrangements in which fuel can be used. Houseless savages, because they know no better, and soldiers at bivouac, because they must make a virtue of necessity, kindle a fire in the open air, and place themselves near it, benefiting by that portion of the radiant heat which falls on their bodies; but all the rest of the heat is wastefully dissipated.

The next step of improvement is, to kindle a fire in a place more or less inclosed. Under this arrangement, not only will that part of the radiant heat which falls on the persons be available, but a portion of the remainder also, which, falling on the walls and warming them, is partially reflected; and moreover, heat combined with the smoke will be for a time retained in the place, and thus still further contribute to the warmth of the interior. By such an arrangement, nearly the whole of the heat evolved in the combustion is applied to use; but it is contaminated with the smoke from the fuel. The savages of North America place fires in the middle of the floor of their huts, and sit around in the smoke, of which the excess escapes by the one opening in the hut that serves as a chimney, window, and door. A few of the peasantry in the remote parts of Ireland and Scotland still place their fires in the middle of their floors, and leave for the escape of the smoke only a small opening in the roof, often not directly over the fire. In Italy and Spain, almost the only fires seen in sitting-rooms are large dishes of live

charcoal, or braziers, placed in the middle, with the inmates sitting around, having to breathe the noxious carbonic acid gas which ascends from the fire and mixes with the air of the room: there is no chimney, and the windows and doors are the only ventilators. The method of warming with open fires in the middle of the room was adopted in some of the English Colleges, and some of the London Inns of Court, down to a comparatively modern period.

A step further in advance is to have a fire, not only in an inclosed space as a means of keeping in the heat, but with an aperture over it to act as a chimney or vent for the smoke. This is the form, under various modifications, adopted in most English houses; the fire being kindled in a kind of recess under a chimney. By degrees we have become accustomed to the adoption of a *grate*, which keeps the fuel at a certain height above the ground; but the principle involved is just the same. In olden times the fire used to be kindled on the hearth under a huge chimney, or on a very low grate; but the general course of modern improvement has tended to lessen the size of the chimney, and to raise the grate higher from the hearth.

The philosophy of a chimney is well explained by Dr. Arnott, in his *Elements of Physics*. He says: "Chimneys quicken the ascent of hot air, by keeping a long column of it together. A column of two feet high rises higher, or is pressed up with twice as much force as a column of one foot, and so, in proportion, for all other lengths; just as two or more corks strung together and immersed in water, tend upwards with proportionally more force than a single cork, or as a long spear of light wood, allowed to ascend perpendicularly from a great depth in water acquires a velocity which makes it dart above the surface, while a short piece under the same circumstances rises very slowly. In a chimney where one foot in height of the column of hot air is one ounce lighter than the same bulk of the external cold air, if the chimney be one hundred feet high, the air or smoke in it is propelled upwards with the force of one hundred ounces. In all cases, therefore, the *draught*, as it is called, of a chimney is proportioned to its length."

Defects of Open Fires.

This being the general arrangement of a fire in a recess on one side of the room, and an open chimney above it, Dr. Arnott enumerates a long list of evils and inconveniences consequent on such an arrangement.

1. *Waste of fuel.*—It has been found that in a common

open English fire, seven-eighths of the heat produced from the fuel ascend the chimney, and are absolutely lost. This lost fuel is thus accounted for. One half of the heat is carried off in the smoke from the burning mass; one quarter is carried off by the current of the warmed air of the room, which is constantly entering the chimney between the fire and the mantel-piece, and mixing with the smoke; lastly, one eighth part of the combustible matter is supposed to form the black and visible part of smoke, in an unburned state. Some writers have even gone so far as to estimate the loss of heat in an open fire at fourteen-fifteenths of the whole. 2. *Unequal heating at different distances from the fire.*—This forms a remarkable contrast with the uniform temperature in the air of a summer afternoon. In rooms with a strong fire, in very cold weather, it is not uncommon for persons to complain of being "scorched" on one side, and "pierced with cold" on the other; this is particularly the case in large apartments; for as the intensity of radiating heat (like light) is only one-fourth as great at a double distance, the walls of the room farthest from the fire are but little warmed, and, therefore, reflect but little heat to the backs of persons grouped round the fire. 3. *Cold draughts.*—Air being constantly required to feed the fire, and to supply the chimney-draught, the fresh air which enters by the crevices and defects in the doors, windows, floors, &c., is often felt most injuriously as a cold current. "There is nothing more dangerous to health than to sit near such inlets, as is proved by the rheumatisms, stiff necks, and catarrhs, not to mention more serious diseases, which so frequently follow the exposure. There is an old Spanish proverb, thus translated,

If cold wind reach you through a hole,
Go make your will, and mind your soul,

which is scarcely an exaggeration." The current of fresh air which enters to feed the fire becomes very remarkable when doors or windows are opened, for the chimney can take much more than it otherwise receives when the doors and windows are shut; and thus the room with its chimney becomes like an open funnel, rapidly discharging its warmed air. 4. *Cold to the feet.*—The fresh air which enters in any case to supply the fire, being colder and specifically heavier than the general mass already in the room, lies at the bottom of this as a distinct layer or stratum, demonstrable by a thermometer, and forming a dangerous cold-bath for the feet of the inmates, often compelling delicate persons to keep their feet raised out of it by footstools, or to use unusual covering to protect them. 5. *Bad ventilation.*—Notwithstanding the rapid change of air

in the room, perfect ventilation is not effected. The breath of the inmates does not tend towards the chimney, but directly to the ceiling; and as it must therefore again descend to come below the level of the mantel-piece before it can reach the chimney, the same air may be breathed over and over again. In a crowded room, with an open fire, the air is for this reason often highly impure. As another source of impure air in a house, it may be noticed that the demand of the chimneys, if not fully supplied by pure air from about the doors and windows, operates through any other apertures. 6. *Smoke and dust.*—These are often unavoidable from an open chimney, much affecting the comfort and health of the inhabitants of the house, and destroying the furniture. Householders would make great sacrifices in other respects to be free from the annoyance of smoke. In large mansions, with many fires lighted, if the doors and windows fit closely, and sufficiency of air for so many chimneys cannot therefore enter by them, not only do the unused chimneys become entrances for air, but often the longest and most heated of them in use overpower the shorter and less heated, and cause the shorter chimneys to discharge their smoke into the room. 7. *Loss of time.*—During the time every morning while the fires are being lighted, the rooms cannot be used; and there are, besides, the annoyances of smell, smoke, dust, and noise, all of which are again renewed if the fire is allowed to go out and to be relighted in the course of the day. 8. *Danger to person and to property.*—How numerous are the losses of property by carelessness as to fires is well known to all, while the less frequent but more distressing loss of life too well attests the danger to children and to females thinly clad often consequent on an open fire.

Such are the principal defects which Dr. Arnott enumerates as being inherent in the use of open fires. Many of them have been greatly lessened by improved arrangements; but others are still without an appropriate remedy.

The usual construction of a fire-place is tolerably familiar. In most cases, the vertical or nearly vertical channel for the chimney is inclosed within a casing of brick-work, which projects into the room at one side. The opening for this chimney gradually narrows upwards, until only large enough to admit the poor little climbing-boy whose task it was, until within a recent period, to sweep down the unburnt fuel which our own ill arrangements have wasted; but, happily for humanity and justice, this system is at an end, and machines are now employed for the purpose. A hearth of stone is laid whereon to erect the stove or grate, and this grate is, as we all know, composed mainly of an iron receptacle for the fuel,

and of "hobs," for supporting culinary vessels. We cause fire to be kindled in the grate, and then suppose that all will go on well, without troubling ourselves to inquire whether the arrangements for the supply of cold air, and the exit of warmed air and smoke, are such as are best fitted for those purposes.

Remedies for some of these Defects.

In course of time, as the evils of this plan became one by one known, attempts were made to remedy some of them, and with an approach towards success. In a recent treatise on the subject by Dr. Fyfe, of Edinburgh, various modes are suggested for remedying many of the evils incident to open fire-places. These we must briefly notice.

Sometimes the rooms of a new house are subject to the nuisance of smoky chimneys simply from deficiency of air. The workmanship of the rooms being all good, the joints of the flooring-boards and of the wainscot panels are all true and tight, the more so as the walls, perhaps, not yet thoroughly dry, preserve a dampness in the air of the room, which keeps the wood-work swelled and close. The doors and the sashes, too, work closely and correctly, so that there is no passage left open for the air to enter except the key-hole, and even this is often closed over by a little brass cover. Thus, air being denied admission into the room, there is nothing to feed the fire and to cause a "draught," and the smoke cannot ascend the chimney. Instances have been known of well-built houses being rendered almost untenantable from this cause, and several hundred pounds being spent in endeavouring to find a remedy. If, on opening the door or window of a smoky room, it be generally found that the smoke disappears, this may be taken as an indication that the close-fitting joints of the wood-work do not admit air enough for the fire when doors and windows are closed. In such a case, the opening of the door or window is a poor attempt at a remedy; for the air proceeds direct to the chimney, and in its way causes cold to the back and feet of those who may be sitting before the fire. Numerous methods have been devised for admitting additional air to the rooms without this inconvenience, among which Dr. Arnott recommends tubes leading directly from the outer air to the fire-place, and provided with what are called "throttle-valves," for the regulation of the quantity. The following plan has also been recommended as one of the most practicable. As the air in the upper part of a room is warmer than in the lower, it is desirable that the supply should come in that direction, so as to

be slightly warmed in its progress towards the fire, and thus produce less chill to those in its immediate vicinity. This may be done by drawing down the upper sash of the window about an inch; or, if not moveable, by cutting such a crevice through its frame; in both which cases, a thin shelf of the length of the opening may be placed to conceal it, sloping upwards, to direct the air horizontally along and near the ceiling. In some houses, the air may be admitted in such a crevice made in the wainscot or cornice near the ceiling, and over the fire-place; this, if practicable, is the better of the two, since the cold air in entering will there meet with the warmest rising air from before the fire, and be soonest tempered by the mixture. Another contrivance is to take out an upper pane of glass in one of the sashes, set it in a tin frame, giving it two springing angular sides, then replacing it, with hinges below, on which it may turn; by drawing in this pane more or less, the quantity of air admitted may be regulated, and its position will naturally direct the admitted air up and along the ceiling. The circular vane or ventilator sometimes fixed in windows admits cold air in a similar manner, when the supply for the room and fire would be otherwise deficient.

The opening or breadth and height of the fire-place, though we may fancy it leads to the diffusion of more heat into the room, is really a cause of loss of fuel, and of smoke. The size of the fire-place opening is often considered in relation to the size of the room, without regard to the principles on which a fire is maintained in a grate; a course about as rational (it has been well observed) as to proportion the step in a staircase to the height of the story, instead of to the convenience of our legs in mounting them. As the chimneys of different rooms are unavoidably of different heights, and as the force of the draught is in proportion to the height of chimney filled with warmed and rarefied air, it is found that the opening for a tall chimney may be larger than for a lower one. If the opening be unnecessarily large, there is room not only for the entrance of fresh air, but also for the exit of smoke driven down by an opposing current from the chimney itself; and the air, too, ascends into the chimney in too cold a state, because the largeness of the opening enables it to enter without passing very close to the fire. The principal evil attending the use of a fire-place having too small an opening, is that the fuel is burned away with unnecessary rapidity. When the opening is found by experience to be so large as to lead to the descent of smoke into the room, the easiest remedy is to place moveable boards or sheets of tin or iron, so as to lower and narrow it gradually. The effect of

which, by excluding a part of the colder air from the chimney, is to produce a quicker action, so that the fire begins to roar as if blown by a bellows. "This means is often used to blow the fire instead of bellows, or to cure a smoky chimney, by increasing the draught. What is called a *register stove* is a kindred contrivance. It has a flap placed in the throat of the chimney, which serves to widen or contract the passage at pleasure. Because the flap is generally opened only enough to allow that air to pass which rises directly from the fire, the chimney receives only very hot air, and therefore acts well. The register stove often cures smoky chimneys; and by preventing the too ready escape of the moderately warmed air of the room, of which so much is wasted by a common fire-place, it also saves fuel." There does not appear to have been any attempt to determine by experiment the proper opening of the fire-place for a given height of chimney; and, indeed, there are so many disturbing causes, that it would be scarcely possible to determine this with precision. Dr. Franklin, however, proposed to make the fire-place openings in the lower rooms about thirty inches square and eighteen inches deep; those in the upper, eighteen inches square, and not quite so deep; and those in the intermediate rooms, of dimensions between these two extremes.

In some cases, where other matters are properly attended to, inconvenience results from the chimney being too low; as, for instance, in the case of an attic chimney. In this instance the column of heated and rarified air is not high enough to give a rapid ascensive power within the chimney, and thus the smoke cannot be carried up. The best method of cure is to add to the length of chimney, if this can be done, and if the fire be in a low building near the ground, this may perhaps be effected; but in an attic, the means of supporting a lofty chimney would be inefficient. Another recourse is to contract the opening of the fire-place to the smallest available dimensions, so that all the entering air may pass through or close to the fire before entering the chimney, and thus acquire an ascensive power which will counterbalance the shortness of the vertical column. It has been recommended that in some cases there may be three chimneys to one room, so that the united length of the whole may be equal to that of a tall chimney; but it is not easy to conceive how this can be practically effected, nor how the desired result would follow, even if the arrangements were made. In some cases, the chimney of a room is rendered practically shorter by being bent round and made to enter the chimney of another room; since, unless there be a fire in this room also, the warm air

from the shorter chimney has often an adverse current to contend against at the junction with the other chimney. This is one reason why every open fire-place should have its own chimney independently of others.

If there be a lofty building or hill near a house, and overtopping the chimney of one of the rooms, that room is very likely to become smoky, on account of a current being driven in at the top of the chimney, and forcing the smoke down with it. Two rival chimneys may produce a similar effect in a remarkable way. Suppose that there were two fires in one room, one burning with more force, and therefore having a more ascensive column of air above it, than the other; if the doors and windows be shut, the stronger fire will overpower the weaker, and for its own demand will draw down air from the chimney of the latter, which air in descending brings down smoke into the room. The same would be observable in a greater degree if one fire-place had a fire in it but the other had none, both being at the same time open. If, instead of being in one room, the chimneys are in two different rooms communicating by a door, the case is the same whenever that door is open. In a house where all the openings, such as doors and windows fitted tightly, a kitchen chimney has been known to overpower every other chimney in the house, and to draw air and smoke into an upper room as often as the door communicating with the room was open. The remedy for this inconvenience lies in the arrangement of the fire-places, so that each fire shall have exactly enough air for the consumption of the fuel, without having to borrow from other rooms.

The arrangement of the door of a room influences materially the proper action of a fire in the fire-place. When the door and chimney are on the same side of the room, and if the door be in the corner, and is made to open against the wall, (an arrangement which is often made for the sake of convenience,) it follows, that when the door is only partly opened, a current of air rushes along the wall into and across the opening of the fire-place, and drives some of the smoke out into the room. This acts more certainly when the door is being closed, for then the force of the current is augmented, and becomes an annoyance to persons who may happen to be situated in its path. When the door and fire-place of a room have been thus ill-arranged with respect to each other, the evil may be lessened by placing an intervening screen between the door and the fire, or by reversing the position of the hinges on the door, so as to make it open in the opposite direction.

Sometimes the smoke from a chimney is driven out into the

room, even when the chimney is not commanded by a superior elevation, it being driven down by strong winds passing over the top of the chimney. Dr. Franklin mentioned one or two instances of this kind which he had met with:—"I once lodged at a house in London, which in a little room had a single chimney and funnel. The opening was very small, yet it did not keep in the smoke, and all attempts to have a fire in this room were fruitless. I could not imagine the reason, till at length observing that the chamber over it, which had no fire-place in it, was always filled with smoke when a fire was kindled below, and that the smoke came through the cracks and crevices of the wainscot, I had the wainscot taken down, and discovered that the funnel which went up behind it had a crack many feet in length, and wide enough to admit my arm; a breach very dangerous with regard to fire, and occasioned probably by an apparent irregular settling of one side of the house." This does not at first thought seem to be an illustration of the effect of wind passing over the top of a chimney; but the explanation is to be sought for in a similar way; the air, by entering this fractured part freely, destroyed the drawing-force of the chimney.

The manner in which the passing of a current of wind over the top of a chimney may produce a "smoky room" is this:—the warm air which rises from the fire, in order to obtain a free issue from the chimney, must repel the air that is hovering over the chimney-pot. In a time of calm or of little wind, this is done easily; but when a violent current is passing over the top of the chimney, its particles have such a strong horizontal velocity, that the heated air in ascending has not power to displace it, and thus the smoke, not finding a ready exit by that path, is driven back into the room.

The following anecdote, told by Dr. Franklin, will show what accidental causes will sometimes occasion a fire to fail in its desired office of yielding heat without smoke:—"Another puzzling case I met with at a friend's house near London. His best room had a chimney, in which he told me he never could have a fire, for all the smoke came out into the room. I flattered myself I could easily find the cause, and prescribe the cure. I opened the door, and perceived it was not want of air. I made a temporary contraction of the opening of the chimney, and found that it was not its being too large that made the smoke to issue. I went out and looked up at the top of the chimney: its funnel was joined in the same stack with others, some of them shorter, that drew very well, and I saw nothing to prevent its doing the same. In fine, after every other examination I could think of, I was obliged to own the insufficiency of my skill. But my friend, who made

no pretension to such kind of knowledge, afterwards discovered the cause himself. He got to the top of the funnel by a ladder, and looking down, found it filled with twigs and straw, cemented by earth, and lined with feathers. It seems the house, after being built, had stood empty some years before he occupied it, and he concluded that some large birds had taken the advantage of its retired situation to make their nests there. The rubbish, considerable in quantity, being removed, and the funnel cleared, the chimney drew well and gave satisfaction."

From these details it will at once appear, that that part of the builder's art which relates to the arrangement and building of the fire-place is by no means an unimportant one, since the comfort of the inmates is seriously affected by want of skill on his part. Hence we may also observe, that chimney doctors are liable to the same kind of errors as quack doctors in another sphere; for it is almost as absurd to attempt to cure all smoky chimneys by one course of proceeding, as to cure all kinds of diseases by one medicine. There may be a deficiency of air in the room; the opening of the fire-place may be too large; the chimney may not have height enough; one chimney may overpower another in its draught; the chimney may be overtopped by higher buildings or by a hill; the door of a room may be badly placed with respect to the window; or, lastly, as in Dr. Franklin's "puzzling case," the chimney may be nearly stopped up. All these are sources of the much-dreaded "smoky chimney," and all require modes of treatment adapted to the nature of the evil. Many of these evils have, to a considerable extent, been remedied by the use of Rumford stoves, and other forms of stove and grate, in which, although retaining all the chief characters of an open fire-place, there is yet a great diminution of the evils to which the latter is liable. There have, however, been marked extensions recently made in the construction of *close stoves*, intended to obviate the ill effects attendant on open fire-places. These must be briefly noticed.

Close Stoves.

In a close stove, no air is admitted but what passes at once through the fire; and the chimney or funnel is only just large enough to carry off the sulphurous and other vapours, for there is hardly any smoke from a close stove, and, therefore, it is not necessary to make a chimney large enough to admit a climbing-boy.

A small German stove, suitable for a room twenty-four feet by eighteen, will give an idea of the general character of this

kind of close stove. The stove rests on a base about thirty-six inches by fourteen. The fire-place has a bottom to receive the fuel, but no bars, and is shut by a door which fits closely to its case. This door has a small wicket at the bottom, the aperture of which is regulated by a sliding plate, so as to admit no more air than will suffice for the slow combustion of the fuel. The flame and heated air ascend to the top of the fire-place, and pass into two hollow pillars or piers, which rise to a height of five or six feet, so that the heat is communicated to a large surface, before the volatilized products of combustion make their exit by a pipe into the chimney. The stove is supplied with fuel and with air by the front door. If it is desired to make the fire visible, and impart some of that cheerfulness which belongs to an open grate, the door of the stove may be thrown open, for there is no danger of the smoke coming out after the current has once warmed the upper part of the stove. When the stove is of such dimensions that the body of it is about two feet and a half high, the fire-place may be furnished with a small grate in the English style. If the door is so hung that it can not only be thrown back, but also lifted off its hinges, it will approach still more to the character of a stove-grate.

A cheap form of "German stove" is often made in this country, and used in workshops and small manufactories, where the body of the stove is an upright cylinder, of which the lower part is the ash-pit, closed or opened by a hinged-door, the middle part the fire-place, where the fuel rests on bars, and the upper part a vacant space, which becomes filled with flame, smoke, and heated air, so as to impart great heat to a flat iron plate at the top. There is a door at which the fuel is introduced, and a small flue or funnel of iron pipe, which conveys the smoke into a chimney or into the open air. Many forms of stove have been used more or less resembling this in principle; but there is one great defect pertaining to them all. The metal of which the stove is formed becomes so highly heated near the stove, that it acquires a *burnt* smell, owing to the decomposition of animal and vegetable particles which are at all times floating about in the air. The air, too, in the room, becomes close and oppressive from another cause; for as only a small quantity of air is consumed by the stove, the air does not become renewed in the room so frequently as when an open fire is used, and thus it is respired over and over again.

To remedy the evils resulting from burnt air, close stoves are made with a double case, so that there shall be a body of air between the fire and the air of the room. It is on this principle, modified in various ways, that a large number

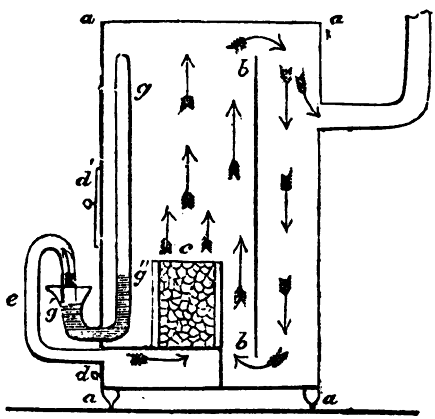
of stoves have been constructed; of which one, by Mr. Sylvester, may be briefly described. There is a hollow cast-iron box, on the outside of which are cast several ribs. These ribs are about three-quarters of an inch thick, and project three or four inches beyond the surface of the box; and their object is to increase the heating surface; for the fire being lighted in the hollow of the box, the conducting power of the iron causes the whole exterior case of the box, together with the projecting ribs, to become heated. The box is placed within an ornamental case, the sides and top of which are fretted with lattice-work, to allow free access to the air, which enters through the lattices at the sides and escapes from the top of the stove, passing in its passage over the ribbed surface of the heated box. The grating on which the fuel lies is formed of a number of loose bars fitted together into a frame, and prolonged so as to emit heat into the room as well as to support the fuel. Everything is so arranged as to give as much iron surface as possible, so as to communicate heat to the surrounding air; while at the same time the extent of the heated surface prevents any one part from being excessively and injuriously heated.

Dr. Arnott's Stove.

To describe all the "chunk" stoves, "Vesta" stoves, "Olmsted" stoves, and other similar contrivances of modern times, would fill a volume instead of a few pages. We may, however, speak briefly of Dr. Arnott's stoves as a means of showing some of the inconveniences to which close stoves are liable, if not constructed with care. This stove consists of an external case of iron, of any ornamental shape. Within this case is placed a box made of fire-clay, to contain the fuel, having a grating at the bottom; and there is a space left between the fire-box and the exterior case, to prevent the communication of too much heat to the latter. The pedestal of the stove forms the ash-pit; and there is no communication between the stove and the ash-pit, except through the grating at the bottom of the fire-box. A small external hole in the ash-pit, covered by a valve, admits the air to the fire; and according as this valve is more or less open, the vividness of the combustion is increased or diminished, and thence the greater or less heat produced by the stove. The quantity of air admitted by this valve is governed by a self-regulating apparatus, either by the expansion and contraction of air confined by mercury in a tube, or by the unequal expansion of different metals. The smoke escapes through a pipe at the back of the stove; but the fuel employed is such as to

yield very little smoke. By adjusting the regulator so as to admit only a small quantity of air, the temperature of the stove is kept within the required limits; and owing to the slow-conducting power of the fire-clay, of which the fire-box is formed, the heat of the fuel is concentrated within the fire-box, and the fuel burns with less air and less rapidity than it would otherwise do.

The construction of Dr. Arnott's "thermometer stove" will be better understood from the following figure, which represents the stove with one of its sides removed, so as to exhibit its interior arrangements:—



The outlines of the figure, *a a a a*, represent the case or body of the stove, which might be formed either of cast or sheet iron. It is divided into two chambers by the partition, *b b;* but in such a way that there may be a free communication at the top and bottom. *c* is a small furnace, or, as it is called by the inventor, a fire-box, made of iron, and lined with fire-bricks. The fire-box is not in contact with the exterior case of the stove. It communicates at the bottom with an ash-pit, the door of which is at *d*,—that of the stove, by which the fuel is introduced, is at *d'*. Both these doors must fit very accurately. Above the door of the ash-pit is a bent pipe *e*, by which air gains admittance to the fire.

A fire being kindled and the doors at *d d'* shut, the only way in which air has access to the fuel is by the pipe *e;* the air so admitted, passing through the fire before it enters the upper part of the stove. That portion of the air not required

to aid the combustion of the fuel having reached the main body of the stove, and there mixing with the smoke and other products, they circulate slowly in the directions indicated by the arrows, and at length pass into the chimney by the pipe *f*.

The slow movement just mentioned as taking place within the stove may well be contrasted with what happens in an open fire-place. In one case the greater part of the heat produced is rapidly carried off by a current of air ascending the chimney—by the thermometer stove it is detained until almost the whole of it has been diffused throughout the apartment.

The bent tube *g* terminating in a cup-shaped opening at g', is a self-regulating valve. The tube is closed at the end *g* within the stove. g' g'' represents mercury which occupies the bend of the tube. When the fire in the stove burns too briskly, the air in the tube occupying the space between *g* and g'' is expanded, and by expelling some of the mercury from the tube at g'' into the cup at g', it closes the aperture of the pipe *e*; thus cutting off the supply of air to the fire. In a few minutes (the fire in the mean time having abated its energy,) the air in the tube will return to its former dimensions, and the mercury subsiding in the cup, air is again permitted to enter the ash-pit.

The stove, of which we have thus attempted to convey a general idea, may be made of any required form or size. Instead of the self-regulating air-valve just described, it is fitted up with others of a very simple construction, and which admit of being adjusted with the greatest accuracy by the hand.

The objections to this form of stove arise chiefly from the formation of deleterious gases, which are not carried off completely. The slow combustion of the fuel produces a large quantity of carbonic oxide, which is liable to escape into the room, and is of an injurious character. Carburetted hydrogen gas is also formed in these stoves. Many modifications of form have been suggested for the remedy of these evils; but the slow combustion, which was one of the merits originally claimed for the stove, and which it certainly deserves, seems an unavoidable cause for the production of these gases.

All the varieties of open fire-place, as adopted in English houses, the hearth, the recess, and the chimney, are at one side or at one corner of the room; but in the adoption of close stoves this arrangement is not necessary; for the stove may be in any part of the middle of a room, provided the pipe constituting the flue be long enough. In some cases this pipe is carried upwards to the ceiling, and thence conveyed to

some outlet into the open air; in other cases it is turned downwards and conveyed under the flooring to a proper place of exit; while in others the pipe is stretched or extended horizontally from the stove to the regular chimney of the room.

Warming Buildings by Heated Air.

Our builders have not yet entered so far into the mechanical contrivances of the age as to dispense with chimneys altogether; nor could such a thing be done until a total change is effected in the opinion of persons concerning the cheerfulness of an "open fire." But there are nevertheless three modes, more or less adopted in the present day, whereby a house is warmed without the necessity for anything like a fire-place. These methods—in all of which the heating agent is brought from another room into the one to be warmed —are of three kinds; heating by *hot air*, by *hot water*, and by *steam*.

When we speak of warming an apartment by heated air, it is necessary to give precision to the meaning of the term. All rooms are, in fact, warmed by heated air, for the stove or grate must raise the temperature of the air in the room before we can appreciate the sensation of warmth. But what is generally meant by the term as here used is the warming of one apartment by air heated in another. The stoves used in Russia, though not coming exactly under this description, will serve in some degree to illustrate the principle.

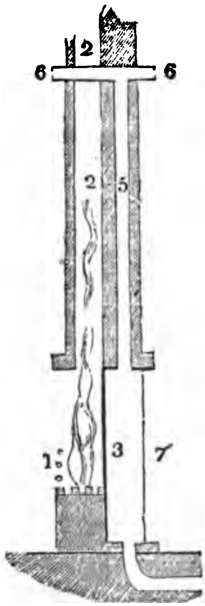
The Russian stove is intended as a sort of magazine, in which a great quantity of heat may be quickly accumulated, to be afterwards slowly communicated to the apartment. The stove is therefore made of a massive size. It is formed of brick-work, clay, glazed tiles, which together form a great mass of matter to be heated by the fuel; and there is in every part a considerable thickness of slow-conducting material between the fuel and the air of the room. The fire is kindled early in the morning, after which the stove door is shut, and the air aperture below left open for some time as a means of admitting draught to the fire; but in the course of a short time the fire-door is opened to check the draught, so as to prevent the too rapid combustion of the fuel. In this way the combustion is allowed to go on, and the substance of the stove becomes warmed, after which the air passages are shut, so as to prevent any abstraction of heat by the current that would otherwise be occasioned. The stove thus becomes a great mass of heated matter, which is gradually pouring warmth into the apartment during the whole of the day; and as the temperature of the surface never becomes very high,

the impurities in the atmosphere are not decomposed, and it is consequently free from those offensive effluvia, unavoidable when metal stoves are used. The fuel is allowed to be nearly burnt out before the apertures of the stove are closed; and therein the stove differs greatly from those hitherto considered; the heated air within the stove being so completely shut in that it can find no outlet, except through the substance of the brickwork.

The modifications of the arrangements whereby warmed air is conveyed from one room to another, may next be noticed. In such cases the air either escapes from a heated receptacle outside the fire-case, or else it merely passes over a heated metallic surface. The following description relates to one variety of the first of these two methods. In the lower part of a house or building is a cast-metal double stove; the inner part forming the stove, and the outer one the case or envelope. The fuel is burned in the inner stove, and the smoke produced during the process of combustion is carried off by a chimney, which passes through both stoves or cases, and is conveyed to the outside of the building. The outer case includes not only the furnace or inner stove, but also a considerable space occupied by the air of the atmosphere, which is freely admitted through a number of holes placed around it; and when any current of warmed air is produced, it passes off from the space between the outer case and the inner stove, and is conveyed by tubes to any apartment in the building; so that the rooms are warmed by the air which has passed between the outer case and the inner stove.

In another form of arrangement, having the same end in view by means of heated air, the air, instead of passing through an enclosed space between the outer case and the inner stove, passes over a surface of metal which is heated either by a fire underneath, or, which is better, by steam or hot water contained in pipes. The temporary House of Commons, the Reform Club-house, and many other buildings, are warmed in this way.

The following simple and cheap form of stove has been erected in the cottages of Sir Stewart Monteath's labourers. The accompanying figure represents a section of the stove, the principle of which will be understood from the following explanatory notes :—



1. *Kitchen fire.*

2. 2. *Chimney.*

3. *Hot air Chamber.* This is a cast-iron box, which forms the back of the kitchen grate.

4. *Cold air pipe, or passage;* made with brick, or stone, or iron piping, communicating with the open air for the purpose of feeding the hot air chamber with an ascending current of fresh air.

5. *Hot air pipe,* receives the ascending current of air, which becomes heated by passing over the back of the fire. At the top this pipe branches off at right angles, and terminates near the floor in the two sleeping rooms above.

6. 6. *Gratings* to admit the warm air from the hot-air pipe into the bed-rooms. The addition of sliding valves over the face of the gratings would serve to cut off the current of warm air during the summer, and when not otherwise required.

7. *Sitting-room,* into which sufficient heat is radiated from the hot air chamber, not only to warm the apartment, but even to dry wet linen.

By means of one common fire in a stove of the above description, a four-roomed cottage can be comfortably warmed, and kept dry throughout.

Warming Buildings by Steam.

The arrangements for warming rooms and buildings by steam are very different from those in which stoves are employed. They are generally such as the following. At a convenient part of the building, and as low as possible, there is placed a close steam-boiler of the ordinary construction. From this boiler a small steam-pipe is carried to the parts of the building which are to be warmed; the pipe being wrapped round with a thick layer of flannel, to prevent the heat from radiating before it arrives at the destined place. Pipes of a larger size are laid round the rooms above the floor, or under a perforated floor, or in any other convenient position. The steam issues into these larger pipes, from the surface of which heat radiates into the room, and thus the steam is condensed

into water. Small pipes of lead or tin are provided for conveying the water back into the boiler, a gentle slope being given to all the pipes to facilitate this object. This water, again flowing into the boiler, is again converted into steam, again ascends to the pipes which surround the apartment, again gives out heat to the air of those apartments, and again flows back to the boiler in the form of water. Thus the same supply of water circulates over and over again through the pipes, carrying heat from the fire below to the rooms above. In some cases the steam-pipes in the apartments, instead of being laid round the sides, are grouped together in a compact form, and have an ornamental character imparted to them.

Instead of pipes, the steam is sometimes made to circulate between parallel sheets of copper or iron, in such manner that every sheet of metal shall have steam on one side of it, and air on the other, the air in that position receiving heat from the steam through the metal.

Warming Buildings by Hot Water.

Lastly we have to notice the method of warming by *hot water*. In this method there is usually a boiler communicating by an upper and lower pipe, with an upright pipe the same height as the boiler. On the application of heat to the boiler, the column of water becomes lighter than that in the upright pipe; therefore the pressure on the water in the lower pipe being less at the end nearest to the boiler than it is at the other end, a portion of the water in this lower pipe moves forward towards the boiler, which causes a corresponding quantity to pass along the upper pipe in a contrary direction. This motion will necessarily continue as long as the column of water in the boiler is hotter, and therefore lighter than that in the upright pipe; and this must be the case so long as the boiler continues to receive heat from the fire, and the pipes to part with their heat to the air, and thereby cool the water contained in them. In whatever form the hot water apparatus is constructed, this difference of pressure of the two columns of water is the cause of the circulation.

In this form of apparatus some part or other of the water is open to the atmosphere, either at the top of the boiler or at the top of one of the pipes, so that there is no danger from the bursting action of water heated above the boiling temperature. But, on the other hand, the water cannot well be conveyed to rooms at different elevations in the building. To increase the efficacy of the arrangement in this respect, the following adaptation has been suggested. A pipe is made to dip into an open boiler, reaching only an inch or two below

the surface of the water, and passing round the room to be warmed, returns again to the boiler and dips again into the water, descending quite to the bottom of the boiler. An air-pump is connected with this pipe by a small tube; and the air in the pipe being exhausted by this means, the water rises into the pipes above the level of the boiler by atmospheric pressure, and the circulation then takes place by the hot water ascending through the pipe at the top of the boiler, and passing through the whole circuit of the pipe, it returns through the upper end of the pipe which reaches to the bottom of the boiler.

In the last-described form of apparatus the water will rise in the syphon pipe to a height of about thirty feet above the boiler, being that elevation which is due to the action of the atmosphere on liquid flowing through a vacuum. But when a whole house or building is warmed by hot water in all the different floors or heights, a modification of the system, called the *high-pressure system*, is adopted.

The apparatus on this system consists of a spiral coil of small iron pipe built into a furnace, the pipe being carried from the upper part of the coil, and entwined round the room intended to be warmed, forming a continuous pipe when again joined to the bottom of the coil. The size of the pipe is usually only half an inch in diameter internally, and an inch externally. A large pipe of about two and a half inches diameter is connected, either horizontally or vertically, with the small pipe, and is placed at the highest point of the apparatus. This, which is called the "expansion pipe," has an opening near its lower extremity, by which the apparatus is filled with water, the aperture being afterwards secured by a strong screw; but the expansion pipe itself cannot be filled higher than this opening. After the water has been introduced, the screw is securely fastened, and the apparatus becomes completely closed in all parts. The expansion pipe, which is thus left empty, is calculated to hold about one-tenth or one-twelfth as much water as the whole of the small pipes; this being necessary in order to allow for the expansion that takes place in the volume of the water when heated, and which otherwise would inevitably burst the pipes, however strong they might be.

In this apparatus the principle of action is different from that in the low-pressure method. Here the water is raised to so high a temperature that it wholly overcomes the effect of gravity, and rises to the highest rooms of a building if required, the circulation through the system of pipes being more rapid as the heat of the water is greater. But there are inconveniences attending the method. If the pipes be

not very strong, they will be burst by the intense pressure from within; as they will likewise if the expansion pipe be too small. If, on the contrary, this latter pipe be too large, it occasions the water to be driven up into it so violently as to leave the lower part of the coil of small pipe almost empty, and therefore liable to be burned by the heat of the fire. And if all these points be properly attended to, there is still the inconvenience resulting from the decomposition of the floating particles in the air, by the highly-heated metal of the pipes. In some cases water, instead of being heated in a coil of small pipes, passes into and through large flat boxes or chambers, whose extended surface enables the surrounding air to be heated more rapidly.

The details of this chapter will enable the reader to perceive, that that part of the builder's art which relates to the construction of the *fire-place* rests on more scientific principles, and is more liable to change by successive discoveries and inventions, than most others. It is not simply to make a square opening by the side of a room, to have a vertical chimney or flue above that opening, and a few bars within it; it is not by such means that the object to be answered by a fire-place can be attained; some knowledge of chemistry, pneumatics, and hydraulics, is required before we can properly regulate the combustion of our fuel, the ventilation of our apartments, or effectually warm them by the ascension of hot air, the circulation of hot water, or the condensation of steam.

Chapter VIII.

THE WINDOWS AND LEAD-WORK.

We must now give to our dwelling-house those conveniences which call for the services of the glazier and the plumber. These two occupations are so often combined by the same tradesman, and the two classes of operations thereby resulting are both so necessary to the finishing of the *exterior* of a house, that we may conveniently treat of them in one chapter.

Introduction of Glass-Windows.

Among the features which distinguish modern houses from those existing in the early ages of English history, few have been more conducive to comfort than the adoption of *Glass-Windows*. Before the employment of that invaluable substance—glass—for this purpose, windows consisted either of uncovered holes in the wall of a house, whereby in order to admit light, the cold would also gain admittance; or else they were holes covered with oiled skin, oiled paper, thin horn, or some other partially transparent material, which would admit a dim light, and yet exclude wind and rain. It is only by placing ourselves in a room thus lighted, that we can form a correct idea of the increase of comfort resulting from the use of glass instead of such imperfectly transparent substances. The slow and imperfect modes of making glass soon after its introduction necessarily gave it a high value, and it could only be employed by the wealthy; but its price has gradually so much lessened, and its claim to a place among the necessaries of life so generally felt and acknowledged, that there are now but few persons in England, except those moving in the very humblest ranks of society, who have not a room with a glazed window.

The Manufacture of Window Glass.

The glass with which windows are generally glazed, is called *Crown glass*. It is formed of different materials in different manufactories. In some instances the materials consist of fine white sand, carbonate of lime, carbonate of soda, and clippings or waste pieces of old glass; while in other cases they consist of white sand, pearl-ash, salt-petre, borax, and arsenic, in certain proportions. On this point we shall not dwell, for almost every manufacturer has a favourite receipt of his own. Whatever substances are employed, they are intimately mixed before being melted. The melting takes place in large crucibles or melting pots, made of a particular kind of clay capable of enduring intense heat.

Several such crucibles are placed in a furnace, a little door being situate in the furnace opposite to each crucible. Through this door the materials are introduced and are suffered to melt; and as soon as these become melted, other portions of the materials are added, until the crucible contains a given amount of melted material. A curious effect is then observable. Although most or all of the materials are nearly opaque in their separate states, it is found that when they are all melted together, they form a transparent liquid, which is *glass*.

It requires about forty-eight hours of intense heat to bring the whole contents of the crucible to a liquid state. During this period, a quantity of dross or impurity, called *sandiver* or *glass gall*, collects at the surface, and is carefully removed; it is afterwards sold to refiners of metals, who use it as a flux. The temperature of the furnace is then gradually lowered, by which means the glass loses sufficient heat to assume a pasty consistence, which is more convenient for the workman than if it were perfectly fluid.

The glass maker then stands before the door of the furnace, exposed to an intensity of heat such as few persons can adequately conceive, and dips into the pasty mass of glass the end of a hollow iron tube about five feet long. On withdrawing the tube, a portion of glass is found adhering to it, and this is made to equalize itself round the circumference of the tube by turning the latter rapidly round. The workman then applies his mouth to the other end, and blows through the tube, whereby the pasty mass is made to assume a hollow globular form at the remote end of the tube. This process is continued for some time and with great dexterity, until the globe has attained a considerable diameter and a proportionably small thickness. The globe is then somewhat flattened at the side opposite to the tube by pressing it upon a hard plane surface; and a solid iron rod, called a *punt*, having a small quantity of melted glass at the end, is applied to the centre of the flattened side opposite to the tube, to which it adheres; the tube is then removed by wetting the glass near the point of union with the tube, leaving a small circular hole. During these processes the glass is repeatedly heated by holding it for a few minutes at the door of the furnace, in order that it may retain the requisite degree of softness.

The *punt*, with the flattened globe of glass at its end, is then rapidly whirled round in a manner nearly resembling that in which a mop is twirled. By this motion, the globe becomes more and more flattened and extended in diameter, until at length, not being able longer to retain its shape, it bursts open, and spreads out in the form of a flat circular

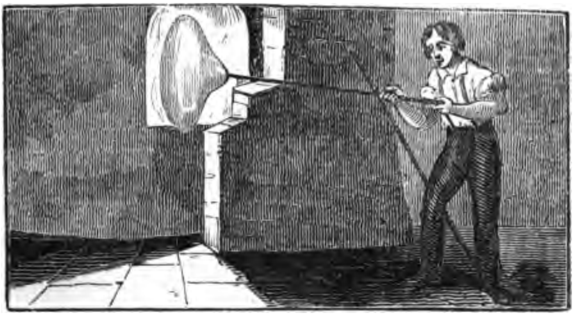
sheet of glass three or four feet in diameter. There is perhaps nothing in the whole range of the mechanical arts more astonishing to a spectator than this process, and there are few that require, from the workman, more of that dexterity of hand which can only be acquired by long practice. The workman continues to whirl the sheet of glass round,—gradually receding from the furnace,—until it is sufficiently set or solidified to retain its form. The punt is then, by a dextrous movement, detached from the centre of the sheet, leaving that bulb which is known as the "bull's eye," or the "knot." The sheet is placed in an annealing oven, the temperature of which is lowered by slow degrees until cold; for it is found that glass is less brittle when it has been allowed to cool gradually than when the cooling has been rapid. Considerable care is required to regulate the temperature of the annealing oven; if the heat be too great the softened glass will bend: if the heat be insufficient the plates are liable to crack, or they prove so brittle that when they come to be used, the glazier will not be able to divide the glass so as to suit his purposes. Indeed, the management of the heat in the manufacture of crown glass requires so much care and skill that few workmen produce an article of the same value, even though working at the same furnace; hence crown glass is known in the market as firsts, seconds, thirds, and fourths; the fourth quality producing less than one-half of the price of the first.

We have not interrupted this description, to refer to engravings; but we may now illustrate it by the following cuts representing the glass in eight different stages of its formation.

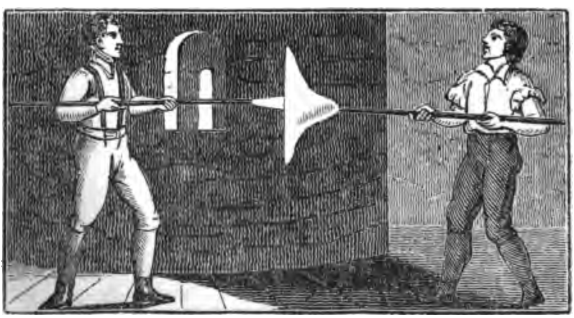
1st. The melted glass attached to the tube, and worked on a board.

2nd. The workman blowing through the tube, to expand the glass.

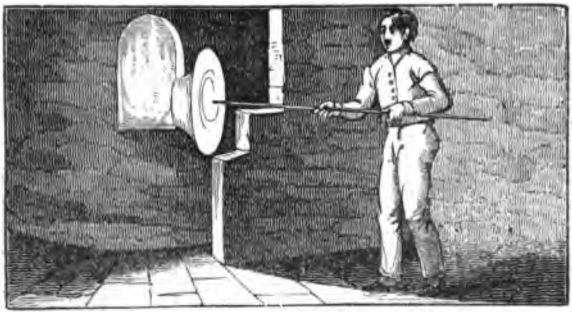
3rd. Whirling it rapidly at the mouth of the furnace.

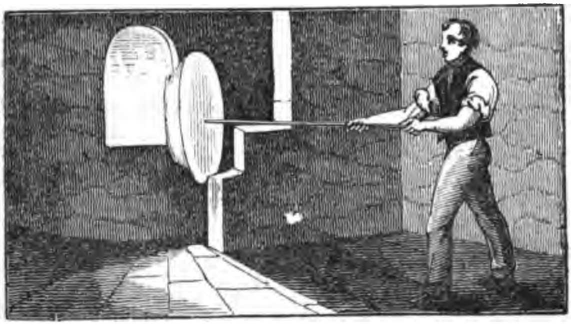


4th. Transferring it from the hollow tube to the solid **punt**.

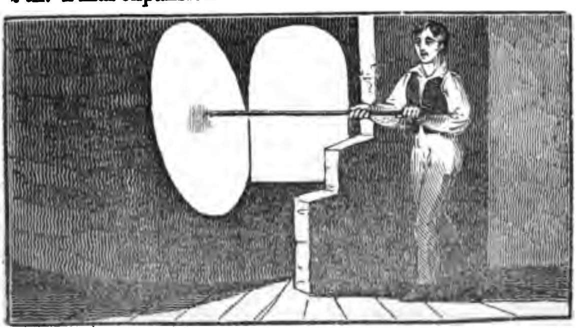


5th and 6th. Successive stages of expansion, by constant and rapid rotation.

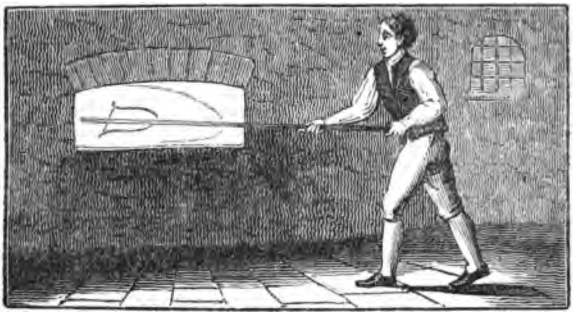




7th. Final expansion into a flat circular sheet.



8th. The sheet of glass, held on a kind of fork, being placed into the annealing oven.



When cold, the sheets of glass are cut into two unequal pieces, one of which contains the *knot*, and are packed with straw in wooden *crates*, in which they are forwarded to the warehouses, and from thence to the glaziers.

As plate glass is sometimes used for windows, a slight notice of it seems to be necessary in this place, in order that the reader may have a clear idea of the difference between these two descriptions of window glass.

The manufacture of plate glass is confined to very few hands, and great reluctance is manifested by the proprietors to permit visitors to inspect their works. The late Mr. Parkes, however, was permitted to visit the works of the British Plate Glass Company, at Ravenhead, and has recorded his observations in one of his valuable chemical essays, from which the following details are taken.

In the preparation of plate glass the materials are selected with greater care than in any other branch of the glass manufacture. The materials employed are sand of the finest and whitest kind, soda, and lime. Manganese and oxide of cobalt are also used for the purpose of destroying colour, which they do by the curious, and at first view, paradoxical property each has of imparting colour. The manganese has the effect of a slight tinge of red, the cobalt of blue; while the sand and alkali produce a slight yellow tinge; and thus these three colours (being those which naturally produce white light) by proper combination in the glass neutralise each other, and the result is an almost perfectly transparent material.

The process of filling the pots and fusing the materials is similar to that already described for crown glass. The cru-

cibles are of two kinds; the larger ones wherein the glass is melted, are called *pots*, and because these when full of glass are too bulky and heavy to be moved, smaller ones, called *cuvettes*, are employed. These are kept empty in the furnaces, exposed to the full degree of heat, so that when the glass is ready for casting and is transferred to them, they may not greatly lower its temperature.

The subsequent operations are very well described in an abstract of Mr. Parkes's essay, given by the writer of the volume on Glass and Porcelain, in the *Cabinet Cyclopædia*.

"When the glass is thoroughly refined, the cuvette—which must be perfectly clean, and, as already mentioned, of a temperature equal with that of the glass—is filled in the following manner:—A copper ladle, ten to twelve inches in diameter, fixed to an iron handle seven feet long, is plunged into the glass pot, and brought up filled with melted glass, which is transferred to the cuvette; the ladle during this transference is supported upon a strong iron rest, placed under its bottom, and held by two other workmen. This precaution is necessary to prevent the bending and giving way of the red-hot copper under the weight of fluid glass which it contains. When by successive ladlings the cuvette is filled, it is suffered to remain during some hours in the furnace, that the air bubbles formed by this disturbance may have time to rise and disperse; an effect which is ascertained to have ensued by the inspection of samples withdrawn from time to time for the purpose.

"Another essential part of the apparatus consists in flat tables whereon the plates of glass are cast. These tables have perfectly smooth and level metallic surfaces, of suitable dimensions and solidity, supported by masonry. At St. Gobain, and formerly also at Ravenhead, these tables were made of copper; the reason assigned for preferring this metal being, that it does not discolour the hot melted glass, while the use of iron was thought to be accompanied by this disadvantage. These copper tables were very costly, both from the nature of their material, and the labour bestowed in grinding and polishing their surfaces; and as the sudden access of heat that accompanied the pouring over them of such a torrent of melted glass occasioned the metal frequently to crack, the tables were by such an accident rendered useless. The British Plate Glass Company having experienced several disasters of this nature, its directors determined upon making trial of iron; and they accordingly procured a plate to be cast, fifteen feet long, nine feet wide, and six inches thick, which has fully answered the intended purpose—having, during several years of constant use, stood uninjured

through all the sudden and violent alternations of temperature to which it has been exposed. This table is so massive, weighing nearly fourteen tons, that it became necessary to construct a carriage purposely for its conveyance from the iron foundry to the glasshouse. It is supported on castors, for the convenience of readily removing it towards the mouths of the different annealing ovens.

"The foundry at Ravenhead wherein this table is used is said to be the largest room under one roof that has ever yet been erected in this kingdom; it is 339 feet long, 155 feet wide, and proportionately lofty. Westminster Hall, to which the superiority in this respect is so commonly ascribed, is smaller—its length being 300 and its breadth only 100 feet. The melting furnaces, which are ranged down the centre, occupy about one-third of the whole area of this apartment. The annealing ovens are placed in two rows, one on each side of the foundry, and occupy the greatest proportion of the side walls. Each of these ovens is sixteen feet wide and forty feet deep. Their floors being level with the surface of the casting table, the plates of glass may be deposited in them immediately after they are cast, with little difficulty and without delay.

"When the melted glass in the cuvette is found to be in the exact state that experience has pointed out as being most favourable for its flowing readily and equably, this vessel is withdrawn from the furnace by means of a crane, and is placed upon a low carriage, in order to its removal to the casting table, which, as it is previously placed contiguous to the annealing oven that is to be filled, may therefore be at a considerable distance from the melting furnace. Measures are then taken for cleaning the exterior of the crucible, and for carefully removing with a broad copper sabre any scum that may have formed upon the surface of the glass, as the mixture of any of these foreign matters would infallibly spoil the beauty of the plate. These done, the cuvette is wound up to a sufficient height by a crane; and then, by means of another simple piece of mechanism, is swung over the upper end of the casting table; and being thrown into an inclined position, a torrent of melted glass is suddenly poured out on the surface of the table, which must previously have been heated, and wiped perfectly clean.

"The glass is prevented from running off the sides of the table by ribs of metal, one of which is placed along the whole length of each side, their depth being the exact measure which it is desired to give to the thickness of the glass. A similar rib, attached to a cross piece, is temporarily held, during the casting, at the lower end of the table. When the

whole contents of the crucible have been delivered, a large hollow copper cylinder, which has been made perfectly true and smooth in a turning lathe, and which extends entirely across the table, resting on the side ribs, is set in motion; and the glass, during its progress, is spread out into a sheet of uniform breadth and thickness. Its length depends upon the quantity of melted glass contained in the cuvette: should this be more than is needed for the formation of a plate having the full dimensions of the table, the metal rib is removed from its lower part, and the surplus glass is received in a vessel of water placed under the extreme end for the purpose.

"Mr. Parkes, in speaking of this operation, remarks—'The spectacle of such a vast body of melted glass poured at once from an immense crucible, on a metallic table of great magnitude, is truly grand; and the variety of colours which the plate exhibits immediately after the roller has passed over it, renders this an operation far more splendid and interesting than can possibly be described.'

"At least twenty workmen are busily employed during this process of casting. From the time that the cuvette is removed from the furnace, to the completion of the casting by the hardening of the glass, the apartment must be kept as free as possible from disturbance; even the opening and shutting of a door might, by setting the air in motion, disturb the surface of the glass, and thus impair the value of the plate. So soon as it is completely set, the plate is carefully inspected; and should any flaws or bubbles appear upon any part of its surface, it is immediately divided by cutting through them."

"When the plate of glass thus formed has been sufficiently fixed by cooling, it is slipped from the table gradually and carefully into one of the annealing ovens, where it remains in a horizontal position; its treatment differing in this respect from that pursued with crown and broad glass, which stand on edge during the annealing process. As each oven in this manner becomes filled, it is closed up by an iron door, the crevices of which are carefully stopped with mortar or clay, to prevent an access of external air to the oven; and thus to provide as far as possible for the gradual cooling of the plates, the necessity for which has already been sufficiently explained. When the glass has remained during about fifteen days in these ovens, they are opened, and the contents withdrawn."

The plates have then to undergo the operations of squaring, grinding, and polishing, which need not be described in this place.

The various kinds of glass manufactured in Great Britain amount every year to the enormous quantity of 300,000 cwt., which is valued at two millions sterling.

Glass Cutting.

Such, then, being a few details as to the mode of manufacturing glass; we will next suppose that the glass has reached the hands of the glazier or glass-cutter; and that the window-frame or sashes are ready to receive the panes of glass.

One of the earlier operations of the glazier is to *prime* the sash, that is, to give it a coat of thin paint, for the purpose of making the putty adhere more firmly to the wood. He next takes the dimensions, in inches and eighths of an inch, of the groove or rebate in which each square of glass is to be fixed, and then proceeds to cut squares of those sizes from the semicircular pieces in his crate. This requires much tact and judgment, since to procure square or rectangular panes necessarily entails a loss of some of the circular portions. The circular sheets are made of diameters varying from forty-eight to sixty-four inches, and these are cut at various distances from the central knot, so that the glazier is enabled to choose that piece which experience teaches him will entail least waste: sometimes it is better to cut the pane from a *table* (the half which contains the knot), sometimes from a *slab* (the remaining portion of the disc).

In order to cut a table or slab, so as to procure a pane of the proper size, the straight edge of the table is placed near the glazier, and he cuts at right angles to it, by means of a diamond, and of an instrument called a *square;* and two other cuts, at the proper distances, are sufficient to give a pane of the required size. With respect to the power by which a diamond is enabled to cut glass, we may explain it by saying, that it is a general rule among mineralogists, lapidaries, and others concerned with stony or crystalline bodies, that the hardest among a certain number of bodies will *cut*, or at least *scratch*, any of the others:—in fact, tables of the *hardness* of different substances are formed from the determination of what substances will mark or scratch others, that one being reckoned hardest which will scratch all others, without being equally affected by them in return. Now the diamond is the hardest body in nature, and cannot be cut by any substance but its own dust; but it can cut glass and other bodies, which are not so hard as itself.

The Process of Glazing.

The glass having been cut to the right size, it is next to be fitted into the sash; and among the many kinds of cement which might be suggested for this purpose, *oil putty* is found to be the most advantageous, since it is conveniently soft when used, but hardens afterwards to the consistence of stone. Putty is made of whiting and linseed oil. The whiting is purchased in lumps, which are well dried, and then pounded and sifted. The linseed oil is poured into a tub, and the powdered whiting added to it, and stirred up with a stick. When some degree of stiffness is attained, the mass is taken out of the tub and placed upon a board, where more whiting is added, and the whole mixed up by hand. The mass is then beaten for a long time with a wooden mallet, until it attains a perfectly smooth and uniform consistency.

A portion of putty is taken up on a knife, and inserted in the groove of the window sash. The pane of glass is then laid in the groove, and gently pressed down in every part, so as to lie on the putty. As the sheets of glass are never perfectly flat, it is a rule among glaziers to let the *concave* side of a pane be within doors and the convex side without. After the glass is laid in, the edge is carefully coated with putty, to the extent of about an eighth of an inch: if this be carefully done, it is sufficient to secure the glass in its place, without presenting an unsightly appearance from the interior of a room. The opposite side of the glass now requires a little attention, since the bed of putty originally laid in the groove has been partially squeezed out by the pane of glass: a little trimming and finishing are all that are required in this matter.

When a broken pane is to be replaced in a window, it is done generally without taking out the sash; but in the case of glazing the sashes of a new house, such as we have been supposing, it is done before the sashes are fitted into their places. If sashes are glazed with *plate* instead of *crown* glass, the only difference in the glazier's method of proceeding is, that the pane being heavier, must be fixed in with greater attention to security. Sometimes a small beading or fillet of wood is used instead of putty, in which case it is either nailed or screwed to the sash.

Where skylights are used instead of windows, a different plan must be observed, since there are no cross bars to the sashes. In this case the squares of glass are fixed in somewhat in the way adopted in slating a roof, that is, the lower pieces are puttied in first, and the upper ones are lapped over

them, so that each pane projects about three-quarters of an inch over the one next below it. This is to effect two objects, —to prevent the necessity of puttying the joints, and to exclude rain.

Ground, fluted, painted, stained, and *embossed* glass, are occasionally employed for windows. These need not be noticed, since the processes by which they are fluted, stained, &c., would carry us to details of too extensive a nature. So far as the glazier is concerned, rather more care and delicacy are required in proportion as the kind of glass employed is more costly or more ornamental.

In some of the better kinds of houses, rooms are provided with double windows, separated a few inches from one another. The object of this is, to prevent the room from being affected by rigorous cold from without; for a mass of air *when stationary*, conducts heat very slowly; the stratum of air between the two windows, therefore,—being stationary,—is slow to conduct the cold from without, or, more correctly, to conduct the warmth from within.

Sheet Lead for Roofs and Cisterns.

Whether the glazier precedes the plumber or the plumber the glazier, or whether the labours of both alternate during the building of a house, is a question of no great importance to our present object. We will therefore proceed to notice the kind of material employed by the plumber.

The comparative cheapness of lead, its admirable qualities, and the facility with which it can be cast and rolled into thin sheets, and drawn into pipes, cause it to be extensively used in building. The most productive mines of this metal in our own country are situated in Derbyshire, Devonshire, Cornwall, in Wales, and in the North; in short, the ore from which lead is generally obtained, called *Galena*, or *Sulphuret of Lead*, is found in all countries where the primary rocks appear at the surface. The ore greatly resembles the pure metal in brilliancy; but it is brittle, and not so easily fused. It frequently contains a sufficient quantity of silver to make it worth while to adopt a peculiar process in the reduction of it, in order to separate this more valuable metal. The ore is first broken into small pieces, and is then *roasted* in a reverberatory furnace, to drive off the sulphur. When this object is attained, the heat is increased, till the metal is fused, and then it is drawn off into moulds, which give it the form of blocks or slabs, called *sows* and *pigs*.

Sheet lead is made thus:—A large furnace is provided, into which pig-lead is thrown, and heat applied. When

the lead is melted, a valve or cock is opened in the side of the furnace, and the glistening liquid metal pours forth, and falls on a large table, covered over with an even surface of fine sand, and having a ledge of an equal height above the sand all round it. When the melted metal is poured on the sand, two men, holding each end of a stiff wooden rule, called a *strike,* draw it along the table, resting on each side ledge: the liquid lead is pushed onwards by the strike, till it covers the whole surface of an even thickness, which of course is governed by the depth of the ledge round the table.

Milled sheet lead is formed by rolling a cast plate of the metal between large iron rollers, turned by machinery. These rollers are set closer and closer together, till the lead is reduced by rolling to the requisite degree of thinness. By this process, the lead is rendered more dense and more equally so, than it ever is by simply casting: milled lead, consequently, is more durable than cast-lead.

It should be here noticed that lead, when it is used for roofing, or for lining cisterns and gutters, is always laid on an even boarded surface, and not on battens or laths, like slate and tiles.

Lead Pipes.

Lead pipe is either formed by bending thin sheet lead round a cylindrical mould, and soldering the joint; or when the pipe is less than four or five inches in diameter, it is formed by casting a thick cylinder of lead with a small bore, and about five or six feet long. A long smooth iron rod, a little larger than the bore of the cylinder, is forced into this, and then the cylinder is gradually drawn through a succession of circular holes, decreasing in diameter, in a steel plate, by means of a powerful draw-mill, worked by a steam-engine. The lead is by this process extended out over the iron rod, which preserves the bore of the pipe of an equal diameter, and when the pipe is sufficiently reduced in thickness, the rod, or *triblet,* is forcibly drawn out, and the pipe left with a smooth bore, ready for use. Attempts have been made to form lead pipes wholly by casting; an outer mould and an inner core being so adjusted as to leave a space between them, into which lead might be forced while in a melted state; but this method has not been practically worked out to any great extent.

The Process of Plumbing.

When a roof is to be covered, or a cistern lined, with lead, the sheet of the metal is unrolled on a level floor, and made

free from creases and undulations, by beating them down with a heavy wooden *flogger*, formed like a roller with a flattened side, and a handle to it. The plumber then draws on the lead the form into which it must be cut to fit the surface it is intended to cover, and afterwards cuts through the lines described with a strong sharp knife. The piece is then rolled up again for facility of carriage, and raised by tackle into its intended situation, it being placed there so that when again unrolled, it may lie in the proper situation and position on the boarding. The sheet is then again beat out flat as before.

The next sheet being put into its place, and so that the edges of the two may overlap about one and a half or two inches, the workman proceeds to make the joint, or to solder the two sheets together. The first step for this purpose is to scrape the two edges or borders of the sheets that are to come in contact quite clean and bright, with a tool constructed for this purpose, consisting of a small triangular bit of steel ground sharp at its edges, and fastened at right angles on an iron socket, fixed in a handle. When these borders of the lead are quite clean, they are painted over with black-lead paint, to prevent their tarnishing, or *oxidising* again, as the solder will only adhere to a clean pure metallic surface. The paint also serves as a flux to cause the solder and lead to melt together, and thus make a close joint.

The solder is melted in an iron ladle, on a rude temporary fire-place, built as near the spot where the solder is wanted as possible. The plumber having turned back the edge of the upper sheet at the joint, an assistant carefully pours the solder on the lower edge. The workman then spreads it evenly along the joint, by means of *soldering irons*, which are irregularly-shaped iron bars, swelling at their ends into rounded forms of different sizes and shapes, according to the particular purpose for which they are intended. These irons are used in a red-hot state in order to keep the solder melted.

As soon as the workman has spread the solder, he presses and hammers down the upper edge upon the lower, and spreads the solder forced out of the joint, along the seam. The outermost edge of the lead covering is nailed down to the boarding or cistern-frame by nails, with their heads leaded over to prevent the corrosion of the metal, by the chemical or *voltaic* action that takes place when two metals in contact are exposed to moisture. The situation of the soldered joints depends on the size and form of the surface to be covered over; and a good workman considers well how he can cut out the lead so as to have the fewest joints, and these in

the most favourable situations. If he has to line a cistern, he will cover the bottom in one piece, cutting the lead large enough to admit of its turning up for an inch or two at two of the sides, the joint consequently being made at these angles.

When a large roof, like that of a church, is covered with lead, this is laid on in parallel bands as wide as the sheet will admit of, the edge of one sheet being turned over a wooden roller or fillet, nailed down on the boarding to receive it, while the edge of the next sheet is turned over the former lead again; the double thickness being well *flogged* down to render the joint water-tight: and in this case no solder is used.

The edges of lead gutters that turn up against the inside of the parapet are either laid as flat against the brick-work as possible, and secured so by iron *holdfasts*, so as to prevent rain from getting in; or to effect the same object, they are in all the better kind of buildings, turned into a joint, in the brick-work, between two courses.

When the plumber has to join two lengths of lead pipe into one, he opens out the end of one length into a funnel-shaped aperture, by gently driving a wooden cone into it, so as to avoid splitting the pipe. The end of the other length is then scraped down a little by the triangular tool before mentioned, not only to obtain a clean surface for soldering, but to allow of the end fitting into the funnel-shaped aperture alluded to. The two pipes being thus put together, the workman holds a thick wadding of old woollen cloth, well greased, under the joint, while a labourer gently pours melted solder over the joint, which the plumber smoothes and shapes down by his soldering-iron and the cloth into a regular smooth rounded swelling, all round the joint, making this perfectly close and water-tight.

We observed in the chapter on "Roofs," that within the last few years, the metal zinc has been much used instead of lead for all the purposes of the latter, and many others beside, for which the admirable qualities of zinc particularly qualify it. This metal is lighter than lead, and equally durable in the open air. It bears water almost equally well; but it is not so flexible or manageable, being neither so fusible nor malleable. Zinc only admits of being rolled or hammered when it is heated to about two hundred and twenty degrees of Fahrenheit. When cold it is too brittle to bear much bending; nevertheless, pipes, gutters, cisterns, chimney-pots, &c., are made out of sheet zinc; and roofs, &c. covered with it.

Solder or Cement for Metals.

The solder alluded to above, as being the means of joining two pieces of sheet lead or of lead pipe, is an alloy of lead and tin, in the proportion of two parts of the former to one of the latter. This mixed metal is fusible at a lower temperature than either the tin or the lead separately; and may therefore be applied in a melting state to tin or lead, which still remains solid, even at the same temperature: this it is which constitutes the principle of soldering. The solder is cast into triangular bars, weighing from thirty to fifty pounds each.

There has, however, been a method recently introduced which seems likely to effect considerable changes in the mode of joining pieces of metal, whether for buildings or for other purposes; and we may here give some account of it.

The great object of soldering is of course to form joints or seams in pipes, and other articles, so perfectly, that they shall be subject to no leakage or flaw. But this object is not easily obtained by the old method of soldering; the chances of flaw are numerous, and have been enumerated thus:—1st, the difference of expansion between the lead and its alloys with tin, a difference which is particularly experienced in very cold or very elevated temperatures; 2nd, the electro-chemical actions which are developed under certain circumstances by the contact of two different metallic substances;* 3rd, the very powerful reaction which a number of chemical agents exert on alloys of lead and tin, though not upon lead alone; 4th, the extreme fragility of these alloys, which, particularly when heated, often break on the slightest blow; 5th, the difficulty of making the solder adhere to the surface of the lead;† 6th, the use of rosin, which frequently conceals fractures for a time.

All of these objections are removed by a new method of soldering, invented by M. E. Desbassays de Richemont, who has recently obtained, at the National Exhibition of Arts at Paris, a gold medal for his invention. The committee on whose recommendation the medal was awarded, included some of the most distinguished chemists and men of science

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* Messrs. Vauquelin and D'Arcet state that they have seen in soap-works the soldering of vats lined with lead crumble in a few days to a powder. The same has been remarked of leaden pipes passing through certain soils.

† The solder often sticks without uniting and the workman may be quite ignorant of his imperfect work; and thus gas, water, or dangerous liquids, may be allowed to escape.

in France; and in their report on the subject, they say:—"We consider this invention of the highest importance; it is applicable to many branches of industry, and will render great service to a large number of manufactures. Its efficacy has not only been proved by experiment, but is confirmed by the fact, that most of our eminent manufacturers and tradesmen have taken out licences for the use of it."

This invention (which is patented in France, Great Britain, and Ireland) is called *autogenous soldering*, and consists of a method of uniting two pieces of metal without the use of solder. The parts to be joined are united by the fusion of the metal at the points or lines of junction; so that the pieces when joined form one homogeneous mass, no part of which can be distinguished from the rest. This result is obtained by means of jets of flame, produced by the combustion of hydrogen gas, mixed with atmospheric air; these jets are so ingeniously managed, that they can be used and directed with as much, or even more facility, than the common tools of the solderer.

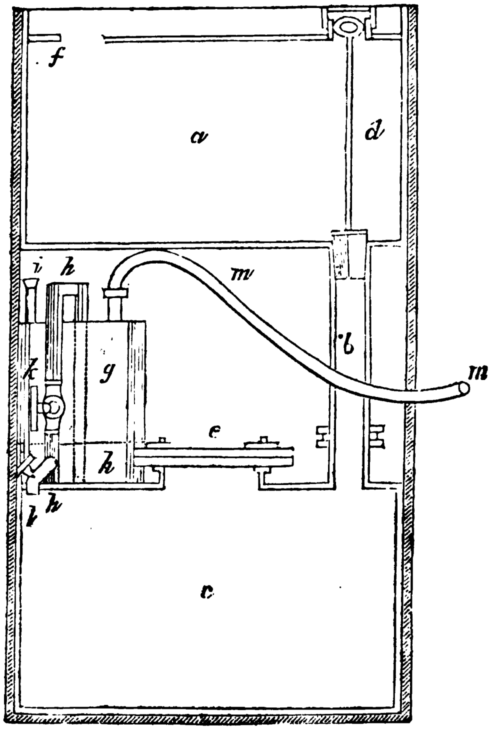
The apparatus employed in this new process consists of a peculiarly constructed vessel for producing hydrogen gas, to which vessel a variety of tubes and jets can be attached, so as to meet the various demands of the solderer.

A section of the gas-producer is shown in fig. 1: *a* is a leaden tank, for containing dilute sulphuric acid; *b*, a pipe which passes from the acid vessel to another similar leaden vessel, *c*, which is to contain cuttings of zinc; *d* is a conical plug, with a stalk and handle covered with lead, by the opening of which the acid is allowed to flow through the pipe *b*, to the zinc cuttings, and thus hydrogen gas is produced; *e* is an opening by which zinc is put into the vessel *c*. The opening, *e*, has a cover furnished with screws and nuts, by which it may be firmly secured; *f* is an opening by which acid and water are poured into the vessel *a*. When the hydrogen gas is produced, it has to pass through the safety chamber *g*; *h* is a bent tube or pipe, which conducts the gas from the vessel *c* to the bottom of the safety chamber, the mouth of the pipe dipping into an inch or two of water in the safety chamber. This water is introduced by the pipe *i*, which is furnished with a stopple. The cock, *k*, cuts off the flow of gas from the vessel *c*, to the safety chamber, *g*. A flexible tube, *m*, is screwed to the top of the safety chamber, and conveys the gas to the working instrument, or jet, in the hands of the solderer.

As long as the dilute acid is allowed to flow upon the zinc, hydrogen gas will be produced: the gas will also be formed as long as the cock is open, which allows the gas to issue as

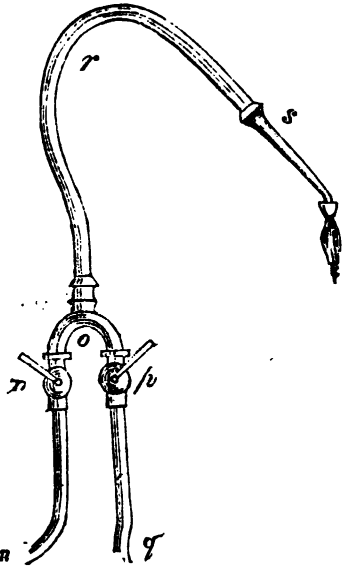
it is produced; but as soon as the cock is shut, a small quantity of gas accumulates, and interferes with the further action of the liquid on the zinc. Consequently there is no danger of an explosion, because the production of the gas is never more than is required for working; and when the work ceases, the

Fig. 1.



production of the gas ceases also. When the dilute acid has become saturated with oxide of zinc, and gas ceases to be produced, the discharging pipe is opened, and the liquid withdrawn. By spontaneous evaporation, this liquid furnishes sulphate of zinc (white vitriol), which may be sold at a price which will more than cover the first and daily cost of the apparatus.

Fig. 2.



We now proceed to describe the part of the apparatus with which the workman operates. In fig. 2, the flexible tube, *m*, is attached to one arm of the forked tube, *o;* the other arm of *o* is attached to a pipe, *q*, proceeding from a bellows, or other means for supplying air. The solderer may work a bellows with his foot to supply his apparatus with air, or the men in a whole factory may be supplied from a blowing apparatus. A cock, *n*, regulates the supply of gas; *p* is a cock for regulating the supply of air; *r* is the pipe or tube in which the gas and air are mixed; *s*, the beak or tool, from which issues the jet of flame, *t*, with which the workman operates.

The forked tube, *o*, is attached to the girdle of the workman, and the regulating cocks, *n* and *p*, are so placed, that by using one hand, the man can allow the exact proportions of air and gas to issue. By stopping both cocks, the flame is of course extinguished.

The beak, *s*, may be exchanged for others of every variety of form, so as to produce jets of flame adapted to any kind of work. Fig. 3 is a tool formed like the rosette of a watering-pot, capable of producing a most intense flame of jets.

Fig. 3.

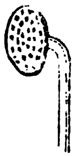


Fig. 4.

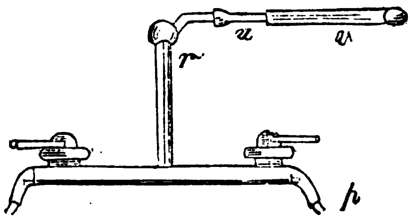


Fig. 4 allows a length of flame instead of a point to be produced; *n* is the hydrogen gas-pipe and cock; *p*, the air-pipe and cock; *r*, the tube, in which air and gas mingle; *u*, a pipe with a longitudinal slit on one side of it; and *v*, another pipe covering *u*, and exactly fitting over it. Gas and air escaping from the slit, on being ignited, will produce a long strip of flame, which may be lengthened or shortened by sliding off or on the covering tube, *v*, on the slit tube *u*.

Fig. 5.

Fig. 5 is a soldering tool, to be used where a jet of flame is not available, as in joining zinc. In this arrangement, the hydrogen and air flame heats a piece of copper, *y*, with which the work is performed. *w* is the tool, with a hollow handle and stalk; air being supplied by the pipe *p*, passes through the hollow handle and stalk; *x* is a small tube which passes down the hollow handle and stalk, *w*, and conveys gas from the pipe *n* to the extremity of *w*, where it mingles with the issuing air, and, on being ignited, the flame will heat the piece of copper, *y*, (which, of course, may be of the shape of any soldering tool required,) held by the arms, *z*.

Advantages of the Improved Method of Soldering Metals.

One great advantage to the public at large to be derived from the general introduction of "autogenous soldering," will be the diminution of the number of cases of the escape of water and gas, which every day occasion so much inconvenience and even danger as regards the stability of buildings, the maintenance of the public thoroughfares, and the security of life.

The disuse of charcoal and tin by plumbers will have the important effect of rendering their trade less unhealthy, the fumes from their brasiers, and the arsenical vapours emanating from impure tin, being a very common cause of serious maladies.

By the old method of soldering, there is great danger of setting fire to houses and public buildings: the destruction of the corn market of Paris, and of the Cathedrals of Chartres and of Bruges, by fire, was partly owing to the negligence of plumbers; a negligence for which there could be no reason, if the new method of soldering had been introduced, since it is only necessary to turn a cock in order to extinguish or rekindle, at any moment, the jet of gas which serves for the plumber's tool. By means of the new apparatus, a soldering flame can be conducted to a distance of several fathoms without the dangerous necessity of lighting a brasier to heat irons, to melt masses of solder, and to carry the whole into the midst of complicated carpentry work.

The disuse of solder will also greatly reduce the price of plumber's work, without, however, diminishing the demand for the services of the workmen. The disuse of seams or overlapping, which from this new mode of connecting lengths of lead will almost entirely be given up, will alone occasion a considerable saving in the quantity of lead employed. The ease with which lead of from one-thirtieth to one-tenth of an inch in thickness may be soldered, and defects repaired, will permit of the substitution of this, in many cases, for thicker lead, and thus diminish the expense; perhaps, also, it will give rise to the use of lead for purposes to which it has not yet been applied, or the return to others, in which from motives of economy it has been superseded by other metals.

The plumber will also be indebted to M. de Richemont's method for several important improvements. He will be able in future to make internal joints wherever a jet of flame can be introduced and directed; to reconstruct on the spot, of pure lead, any portion of a pipe, a vase, or a statue, that may

have been removed or destroyed; to execute in rapid succession any number of solderings; to repair in a few minutes all dents, cracks, and flaws, in sheets or pipes of new lead; to remove entirely the enormous edges or knots left by the old-fashioned joints, and that without weakening them; to give, in short, to works of lead a precision of execution, and a solidity, unattainable up to this time.

Autogenous soldering will also be of great assistance to several chemical manufactures, where it is so important to have large vessels of lead without alloy. By uniting a number of sheets into one, vessels of pure lead of any size may be formed for the process of acidification and concentration of saline solutions; for the formation of scouring vats employed by so many artisans who work metals; for vessels of every kind used to contain liquids which act upon tin solder.

In the repair of leaden vessels exposed to the action of heat, peculiar advantages are offered by autogenous soldering. By the old method, the holes which are so often caused in the bottoms of these vessels, either by the action of sudden flames, or by deposits that form on their surface, can be stopped only when they are not of too large dimensions, by making what are called weldings of pure lead. The cases in which this mode of repair is available, are very limited, and whenever it is impracticable, the boilers must be taken down, the lead changed, and then reset; thus occasioning considerable expense and an interruption to business. By the new method, nothing is easier than to apply pieces to the bottom or sides of the vessels, whatever be the size of the holes, and thus the whole of a boiler may be renewed piecemeal. By this plan, too, the old lead remains uncontaminated with solder, and consequently will yield a pure metal to the melting-pot.

The great ductility of lead, which, in many cases, is one of its most valuable qualities, is, however, an inconvenience when instruments or utensils are required of considerable strength. At the same time, there are circumstances where this metal alone can be employed, on account of the manner in which it resists chemical action. By constructing vessels or instruments of iron, zinc, or wood, and covering them with lead, utensils can be formed that will resist pressure and blows, and most chemical agents, as well as if they were made of solid lead. Such vessels are required in the preparation of soda, and other gaseous waters; in the distillation or evaporation of acid or alkaline solutions; and for many other purposes.

Another application that deserves especial notice is that of lining common barrels with thin sheet-lead. These vessels

would be of great utility in chemical factories, more particularly in the construction of Woulf's apparatus, and other pneumatic instruments, to which greater dimensions could be given by this means; but they could be employed with singular advantage in the transport of acid and alkaline liquids by sea and land. Sulphuric and muriatic acids are transported in stone bottles, or glass carboys placed in baskets, which, however carefully packed, are liable to be broken, not only with the loss of the acids, but with danger to surrounding bodies. We are told of two French ships that perished at sea on a voyage to the colonies, in consequence of the breaking of some bottles of sulphuric acid.

In the manufacture of sulphuric acid, the use of ordinary solder is impracticable, since it would soon be corroded. The following method was introduced some years ago for forming sulphuric acid chambers, and the concentration pans. Two edges of lead being placed in contact, were flattened down into a long wooden groove, and secured in their situation by a few brass pins driven into the wood. The surfaces were next brightened by a triangular scraper, rubbed over with candle-grease, and then covered with a stream of hot melted lead. The riband of lead thus applied, was finally equalized by being brought into partial fusion with the plumber's conical iron, heated to redness; the contact of air being prevented by sprinkling rosin over the surface. The autogenous soldering apparatus will greatly simplify the above method.

The advantages to be derived from the new process, are by no means confined to lead: the apparatus may be employed in using for solder either the common alloys, or pure lead, to unite zinc, and iron, and lead, with iron, copper, and zinc. It may be substituted also with advantage for the common blow-pipe and lamp of the enameller in all their applications to the soldering and joining performed by the aid of these instruments by jewellers, goldsmiths, tinmen, manufacturers of plated goods, of buttons, &c.

The flame produced by the combustion of the gas may be most economically employed for heating soldering irons. A few seconds suffice to bring the iron to the desired temperature, and it can be kept at that temperature for many hours without being liable to burn, nothing more being necessary than to regulate the flame by means of cocks, and the workman need not be obliged to change his iron, or even to leave it for a single moment. Hence there is not only a considerable saving in manual labour, but also in fuel, which in most cases is of greater consequence.

Such are a few only of the advantages of this simple and beautiful invention, which is now very extensively adopted in

France, and will doubtless get into extensive use in this country, when its merits are more generally known.

It may be here stated, in justice to some of our own ingenious countrymen, that after this method had become extensively known, M. Richemont's claim to the invention was disputed. We have been informed, that previously to the year 1833, a Mr. Mallet had employed an apparatus constructed on the same principle, and used in a similar manner, as that already described as the invention of M. de Richemont. In LOUDON'S *Encyclopædia of Cottage Architecture*, published in 1833, the following passage occurs:—"Mr. Daniell, of King's College, London, has since published the same thing as new, and of his invention; however, I can establish priority by my laboratory journal."

Chapter IX.

THE INTERIOR—PLASTERING AND PAPER-HANGING.

As men rise above the rude condition of uncivilized nations, they are not satisfied with the mere *necessaries* of life. Their standard of comfort becomes elevated. Those things which are luxuries to the lowest class are comforts to the next higher class, and necessaries to the class which is higher still in the social scale; so that the interpretation given to the words, "luxuries," "comforts," and "necessaries," becomes a sort of index whereby to mark the grade which an individual occupies. A roof to cover the dwelling, a glass window which may exclude the wind and the rain, while it admits light,—a fire-place, with appliances for carrying off smoke and the products of combustion—however far above the standard of the uncivilized man—are not sufficient for the Englishman of middle station. He must have his rooms nicely squared and neatly fitted; the roof must be concealed from view by a smooth white ceiling; the rough brick walls must be covered not only with plaster, but with an ornamental covering of paper or paint. Hence arises occupation for many artisans whose sole business is to make the dwelling agreeable to the eye, after the more necessary and indispensable parts of the structure have been finished.

Plastering Walls and Ceilings.

The occupation of the plasterer is generally united with that of the bricklayer. The business of the plasterer, as such, is to cover over the rough walls and ceilings of a building with *plaster*, which is the name given to a better kind of mortar, made of lime only. When this plaster is of the coarser kind for the under or first coating, cow-hair is mixed with it to make it bind better. When a plain brick wall is to be plastered, the surface is at once covered with the plaster, this adhering readily to the rough brick-work: but for ceilings or partitions, a groundwork of laths is required to receive the first coating.

Laths are of different sizes and qualities, according to the various work for which they are intended. Those used by the plasterer are termed *single*, and are about from two to three feet long, an inch broad, and a quarter of an inch thick. They are split out of a coarse kind of deal. *Double* laths are considerably longer and thicker, and are sawn out:

they are therefore regular in their size. They are used for better work in plastering, but chiefly by tilers or slaters.

The single laths are nailed up to the joists of the ceiling, or to the *quartering* of partitions, with but a small interval between each, so as entirely to cover the surface. The workmen then proceed to cover the lathing with coarse plaster, a labourer supplying them with a small quantity at a time on a square board, held in the plasterer's left hand by means of a short thick handle stuck upright into the back of the board. The man uses a rectangular flat wooden trowel, with a bridge-shaped handle, to transfer the *stuff* from the board to the wall, and to spread it evenly over the surface. When the room of which the walls are being plastered is of a better description, the work is *floated*, that is, a regular surface is obtained by drawing a long straight-edge over the wet plaster, so as to scrape off the inequalities and reduce the whole to a plane surface.

A thinner coating of finer plaster is spread over the first to finish the plastering, and this is again floated in drawing-rooms, and so on.

Plaster and Papier-Maché Ornaments for Rooms.

The mouldings of cornices in rooms are formed by a wooden mould drawn along a straight-edge to guide the mould, acting like the carpenter's plane, when forming analogous mouldings in wood. When such cornices are of sufficient size and depth to require it, wooden brackets, shaped something like the profile of the cornice, are fixed up against the wall, and laths are nailed on these brackets, to serve as a foundation for the mouldings. By this means the necessity for a heavy mass of plaster, to get the requisite projection in the cornice is avoided; which mass would be unwieldly to manage, and liable to fall down by its weight.

Foliage and ornamental work in plaster is made by *modelling* the ornaments by hand, in a proper kind of clay, worked by steel or wooden tools, resembling small spatulas in form. To do this requires a taste and skill in drawing or designing in the workman, which raises him to the rank of an artist. When the model is finished and dry, the surface of it is covered with a thin coat of oil, and a mould of fine plaster is taken from it in separate pieces. To allow of the plaster mould being taken off the model, the edges of these separate pieces of the mould are made smooth so as to fit accurately together. From this mould any number of *casts* may be taken by pouring fluid plaster into the mould when it is put together; and as soon as each cast has *set*, or become hard,

the mould is taken off it, to be put together again for a new cast. There has been recently an improvement introduced, which leads to a diminution of the use of plaster for ornaments; this is by the substitution of *papier-maché*. The material so named is formed chiefly of paper, brought to the state of a paste, and then compressed in moulds. There is to every ornament so made a counter-mould, following the general contour of the ornament, so that the piece is made about equally thick in every part. The resulting ornament is very much less ponderous than those made of plaster, and much less liable to fracture. The interior decorations of many buildings are now made of this material.

Whitewashing and Stuccoing.

Old plaster ceilings, walls, &c., are cleaned by being *white-washed*. The plaster is first washed over with clean water, by means of broad flat brushes, to remove the dirt. All cracks and defects in the plaster are then *stopped* by filling them up with new plaster, and it is frequently necessary to cut away the plaster in such places to obtain a clean new surface to enable the new plaster to adhere. When the surface is dry, the whitewash, made of whiting mixed up in water, is laid on with the same form of brushes, and two or three times gone over, so as effectually to cover all stains and marks on the surface. Instead of being whitewashed, walls are frequently coloured by mixing ochre, of the proper tint, in the water along with the whiting.

The outside of walls of houses, &c., are now frequently covered with stucco, a kind of plaster made with a lime that resists the action of water, when set, and which, if well managed, causes the wall to look as if built of stone. The mode of stuccoing walls is exactly the same as that of covering them with common plaster.

Origin of Paper-hangings.

In early times, wealthy people were accustomed to have the walls of their rooms covered with *tapestry*, which was a combination of woven cloth and needlework, somewhat midway between the *sampler* work and the *carpet* work of our own day. These specimens of tapestry frequently represented some historical events, and were often worked by the hands of the lady of the mansion and her maids; but at other times were the work of men following that line of occupation. The walls of those rooms which were not thus covered, were usually of panelled wainscot, or oak.

But when tapestry went out of fashion, and a more lively covering for a wall than oak was wished for, a custom arose of printing or stamping certain coloured devices on sheets of paper, and of pasting those sheets against the wall. We believe that it is in England more than in any other country that this covering for walls is employed; and since the removal of the duty which was formerly laid on paper-hangings, they have become so very cheap as to be almost universally employed in houses of every class; indeed, it may be regarded as a circumstance not a little conducive to the comfort and neatness of humble dwellings, that a yard of printed wall-paper can now be purchased for *one halfpenny*. From this trifling price up to five or even ten shillings per yard, paper-hangings are now manufactured; so great are the improvements gradually made in the modes of manufacture.

The Manufacture of Paper-hangings.

It will be interesting to give a brief description of the mode of making, or rather printing, paper-hangings, before we speak of the employment of the paper-hanger; for all that devolves upon him is to fix up the paper when printed.

The paper employed is a sort of cartoon or cartridge paper manufactured for the purpose,—rough, but strong. Until recently, every piece of such paper was stamped, and the excise duty paid on it, before the process of printing commenced.

In general, the paper is printed in "distemper," that is, in colours mixed with melted size, but sometimes in varnish. The pigments or colouring substances employed, are principally these:—*Red* or *crimson*,—lake, vermilion, rose-pink, and red ochre:—*Blue*,—Prussian blue, verditer, and indigo:—*Yellow*,—Dutch pink, yellow ochre, and chrome yellow:—*Green*,—verdigris, and various mixtures of the blues and yellows just mentioned:—*Orange*,—vermilion, or red lake, mixed with Dutch pink:—*Purple*,—a wash made of logwood, and various mixtures of lake with Prussian blue, or with indigo:—*Black*,—ivory black and lamp black:—*White*,—whiting and white lead. There are other substances occasionally used, according as improvements or discoveries are made in the manufacture of colours; but various combinations of those which we have mentioned will yield almost every tint that can be desired.

These colours are mixed with water, together with a little size or gum, by which the colours are made adhesive without being too stiff for working. If the paper is to be glossy when completed, or if any one of the colours with which it is

printed is desired to be glossy, the pigment for that colour is mixed with oil of turpentine and certain gums and resins which will give a glossy surface to the paint when dry. Before the printing commences, the piece of paper (which is about twelve yards long) is coated all over with that colour which is to form the *ground*. Powdered whiting is mixed with melted size to a proper consistence, and laid on with a large brush, in the same manner as a ceiling is whitewashed: the piece of paper is then left to dry. If the ground is to be white, nothing more is required before the printing; but if it is to be coloured, a second ground is laid on, made of melted size, and of such colouring substances as will give the required tint: this, when dry, is the ground which is to receive the ornamental pattern. If the ground is to be glossy, the colouring substance is mixed with varnish, gum, resin, &c., instead of size and water.

When the ground is thoroughly dried, the device is laid upon it, and this is, in most cases, done by a process almost exactly corresponding with wood-cut printing, in the fine arts. An impression is taken from wooden blocks, which are cut in such a manner that the figure to be expressed is made to project from the surface, by cutting away all the other parts. But this raised device only represents that portion of the whole figure which is to be of *one* colour; so that if the pattern is to be ultimately represented in four colours, as is frequently the case, there must be four differently-carved blocks or stamps to represent these, and the blocks must be so carefully carved with reference to one another, that though the sizes of them are all exactly alike, the devices occupy different parts, and do not interfere with one another: the whole beauty and correctness of the figures depend on the accuracy with which the blocks are carved.

Suppose, now, that the paper is properly painted with the ground colour, dried and spread out on a flat board,—the carved blocks ready for use,—and the colours mixed and melted in a warm state,—the process is then conducted as follows. A piece of leather or of oilskin is stretched over a flat block, and a boy lays a coating of one of the colours to be used—say green—on the leather, with a brush. A man then takes that one of the carved blocks which is to stamp the green part of the device, and lays it down flat on the wet colour, by which a coating is transferred to all the raised parts of the block. This is then stamped down, with a firm and steady pressure, upon the piece of paper, by which the green device is permanently impressed. As the carved block is only large enough to stamp a small portion at a time, an adjoining portion of the long piece of paper is taken,—a fresh

coating of colour laid on the leather by the boy,—this coating again transferred to the carved block,—and again from thence to the paper. This continues until the whole length of the paper is printed with the green device, care being taken that the different impressions shall accurately join one another at the proper parts.

The paper is then laid aside to dry, and preparations are made for printing the second colour upon it.

Let us suppose this colour to be *pink*. The proper ingredients are mixed with size, and melted, and a coating of this laid on a block covered with leather, as in the former case. The proper carved block is then taken, and an impression stamped by its means in precisely the same manner as before, with the exception of the colour being pink instead of green. But in laying the wet stamp on the piece of paper, great care is requisite in adjusting the two colours so that they shall not interfere with each other:—for instance, if the green represents leaves and the pink represents flowers, it is important that the pink should not, by a misadjustment of the second stamp, go over a part already occupied by green, so as to give a confused mixture of green leaf and pink flower at the same spot. If we closely examine the pattern of paper-hangings on the walls of our rooms, particularly the inferior papers, we shall frequently see instances of the bad adjustment to which we here allude.

The pink stamping proceeds from end to end of the piece of paper, until the whole is done; after which it is laid aside to dry. A process precisely similar in every respect is followed with all the subsequent colours, be they few or many. The more complicated the figure is, or the greater the number of colours it contains, the greater is the degree of care required in impressing the successive colours on the papers. In order that no time should be lost, directly the workman has taken a supply of colour on to his block, the boy lays on another coating on the leather. Indeed, the whole process very much resembles the rudest kind of *printing*, with the exception of the use of different colours.

The description we have here given is such as will afford a general idea of the nature of the process. Various improvements have been from time to time introduced for facilitating the printing; but it is hardly necessary to dwell upon them.

Stencil, Washable, and Flock Paper-hangings.

In some of the cheaper papers, the preparation of the carved wooden block, and the time and attention necessary in

using them, would be incompatible with the charge made for the finished article: an alteration is therefore made in the mode of proceeding. The principal outline is printed on the paper by means of a carved block in the usual way; but the remaining colours are put in by *stencilling*. A stencil, or stencil-plate, is a piece of leather, oil-cloth, or thin sheet metal, with any required device cut in it. Such a stencil is laid down flat on the paper, and is covered with the required colour by means of a brush. This colour of course passes through the holes in the stencil, and falls on the paper, while the uncut parts of the stencil prevent the colour from falling on any other part of the paper. A device is thus painted on the paper in a much easier manner than by the use of a carved block. But from the nature of the process it is found that the delicate parts of the pattern cannot be represented by this means, as it is difficult to ensure the passage of the colour through small perforations. But for the purposes to which stencilling is applied—viz., the preparation of cheap paper-hangings, this delicacy is not required. One or more carved blocks are used with the stencil plates according to circumstances, the choice between blocks and stencils depending both on the nature of the pattern, and on the value of the paper when finished.

Some of the more costly kinds of paper-hangings have gold as one of the materials forming the device. This is effected by using a wash of gold powder, instead of a pigment, on one of the carved blocks. There are also *washable* paper-hangings, in which the surface is of a glossy or varnished nature, by which it may be washed free from dirt and grease without removing the colours with which the paper is printed. There is likewise a kind of paper-hangings called *flock* paper, which has been much in use, and of which the following description has been given.

The flock is woollen cloth reduced to great fineness, and laid on with varnish. After the coloured portions of the paper are finished, a carved block representing the device which is to be flocked, is laid down on a flat place coated with wet varnish, and an impression of the varnish is transferred to the paper, just as if it had been a coloured pigment. A quantity of the powdered flock is then strewed over the whole paper, and pressed on it by a flat board, a roller, or some other convenient means. The paper is then left to dry, after which the dry flock is brushed off from those parts where no varnish had been applied, leaving an appearance much resembling that of coarse woollen cloth, which our readers may frequently have noticed. The flock is prepared in various ways. Sometimes pieces of woollen cloth of the

proper colour are taken, and chopped up by means of a bill or knife; but this is a rude and imperfect way, now probably out of use. Another mode is, to place the pieces of cloth in a flat box, and cause a sharp knife, moved by machinery, to pass rapidly, with a chopping motion in every direction over the various pieces of cloth. In some cases, also, the cloth is reduced to flock by a kind of grinding process.

The Process of Paper-hanging.

This, then, is an outline of the mode by which paper-hangings are prepared; and we must next speak of the method of pasting them against the walls of a room. As the long pieces or strips of paper do not average more than two feet in width, it is obvious that a great many joints must be made in covering the side of a room with paper. These joints proceed not crosswise, but perpendicularly from the ceiling downwards; and considerable care is necessary to insure the continuance of the pattern on the two sides of a joint: it is in this that the principal art of the paper-hanger consists.

A strip of printed paper twelve yards long is called technically *a piece*. This piece has ragged unfinished edges, and the edges are to be cut away in a straight even line until a proper part of the pattern is reached; for the blocks are so carved, that one edge always corresponds exactly with the opposite edge. The wall, which is generally plastered, is washed or sized, and made fit to receive the paper. The cement with which the paper is fixed up is thin paste; and when that paste is ready, the paper-hanger proceeds as follows. Supposing the height of the papered part of a room to be twelve feet, he cuts off four yards from his piece of paper, with the two ends accurately at right angles to the long edges. He then lays it down on a flat board or bench, face downwards, and coats the whole of the back of the paper with liquid paste, by means of a brush. He then slightly folds the paper over, so as to prevent it from dragging on the ground, and, mounting a ladder or a pair of steps, applies one end of the paper to the upper part of the wall, close to the cornice: then, by letting the paper unfold itself, it falls to its full length, and extends down to the bottom of the room, close to the wall. The workman has now to judge, by the eye, whether the edges of the paper are perfectly vertical, for the whole beauty of the work depends in a great measure on this circumstance. When he has ascertained that the paper hangs perpendicularly, he proceeds to press it firmly to the wall, by means of cloths; and the paste has so far softened

the paper, that wrinkles of every kind disappear. This done, he cuts off another piece twelve feet, or four yards long, and pastes it against the wall in precisely the same manner. But here great precautions are necessary; for the workman has to attend to three particulars in fixing the second piece by the side of the first:—to cause it to hang vertically,—to make an accurate joining of the pattern,—and to refrain from soiling the surface of the first piece by the paste of the second. All these are precautions which can only be properly attended to after considerable practice.

When the workman is approaching an angle or corner of the room, he must cut his paper to such a width as will just reach the corner, for it is generally difficult to bring the paper round both sides of the angle. In the case which we have supposed, the height of the room is just one-third the length of the piece of paper, so that there need be no joints at any intermediate part of the height. But if the height were any other amount,—say ten feet—three pieces of that length would leave a fourth only six feet long; and as such a piece is not likely to be wasted, it follows that there must be a joint at some intermediate point between the floor and the ceiling. Such a joint requires especial care, as the pattern has to be attended to both in a vertical and a horizontal direction.

When the side of a room is broken by recesses, projections, &c., a good workman will so arrange his pieces of paper as to give a symmetrical appearance to the two sides of a projection of a recess, so that the same part of the pattern which comes to the right hand edge shall also be seen at the left hand. In papering a staircase, when the upper and lower edges are oblique and not horizontal, it is of course necessary that the ends of the paper should be cut in a corresponding manner, in order that the long joints should be vertical.

As it is difficult to bring the ends of the paper precisely to the cornice at the top and to the skirting-board at the bottom, it is usual to hide those ends by pasting a narrow strip of paper along the top and bottom of a room, which gives a neat finish to them. This strip of paper is printed in colours with some pleasing device; and as a broad piece is printed as quickly as one two or three inches wide, it is customary to carve a block with twelve or twenty repetitions of the same narrow pattern, side by side; so that the whole are printed on one sheet. The paper-hanger has therefore carefully to cut the strips one from another, and paste them round the wall at the parts which we have mentioned, and sometimes up the corners of the room likewise.

It is sometimes preferred, instead of papering the walls of

a room, to *stencil* them. In this case the plaster of the wall is prepared in a smooth manner to receive the distemper colour, and the pattern is stamped or printed on the wall in a manner almost exactly the same as that which we have described respecting stencilling paper-hangings. This mode is not susceptible of so much neatness as the use of printed or stamped paper, and is only employed for common apartments.

There is occasionally a kind of work which falls into the hands of the paper-hanger very different from those we have mentioned—viz., fixing gilt wood mouldings round the top and bottom of a room, instead of pasting a paper bordering in the same place. What little we shall have to say on this subject will be contained in the following chapter.

Chapter X.

THE INTERIOR—PAINTING AND GILDING.

Reasons for Painting a House.

The love of neatness and elegance which distinguishes the cultivated from the rude man in the decoration of his dwelling, is not the only motive for these interior fittings of a modern house. There are in many instances manifest advantages, in relation to dryness and durability, resulting from such arrangements. Such is the case with respect to one of the two processes which will occupy the present chapter. In noticing the services of the house-painter, it will be found that they are conducive to something more than our love of colours and tasteful decoration, for they greatly promote the durability of wood and iron work. Wood of almost every kind is liable to injury from the effects of the atmosphere, if left unprotected; but when coated with oil-paint, its power of resisting those effects is much increased. Cleanliness is also more easily preserved where paint is employed. If a room door, for instance, were not painted, it would require the same scouring and cleaning which an uncarpeted floor so often receives, though perhaps not so frequently. When we consider, therefore, that durability, cleanliness, neatness, and pleasing decoration, are all derived from the judicious employment of oil-paint in a house, we shall conclude that a painter renders important service in the preparation of a dwelling-house.

Materials used in House-painting.

House-painting, in most cases, consists in laying on several coats of some mineral substances mixed up to a fluid consistence with *oil*. There is no other liquid body which is found to have so many advantages for this purpose as oil; for although turpentine, milk, beer, spirit, and other liquids are occasionally employed, oil is the standard material with which the colouring substances are mixed. The colouring substances, as well as the oils, employed in painting, are very numerous; and we can only offer a brief description of the principal among them.

White lead is the most valuable of all the colouring bodies, since it enters into the composition of almost every other. It is made by exposing sheet-lead to the action of vinegar, by which a white substance is procured. *Bougival white*, and

Spanish white, are mineral substances procured from abroad. *Chrome yellow, Turner's yellow, Massicot, Naples yellow, King's yellow, Orpiment*, and *Ochres*, are various bodies of a yellow colour, some derived from earths, others from ores, and others from chemical treatment of metals. *Vermilion, Carmine, Cochineal lake, Madder lake, Red lead, Indian red, Venetian red*, &c., produce various tints of red and crimson; but the materials themselves are derived from very different sources. Vermilion is a compound of sulphur and mercury; Carmine and Cochineal lake are prepared from an animal substance; Madder lake from a vegetable; Red lead is an oxide of that metal; while the others are derived from various kinds of earth. For a *blue* colour, the painter employs *Prussian blue*, which is a compound of prussic acid and iron; *Indigo*, derived from a plant growing in the East Indies; *Blue Verditer*, a nitrate of copper; and some other substances. Most *green* paints are made of salts of copper, such as *Verdigris*, which is an acetate of copper; *Scheele's green*, an arseniate of copper; *Green Verditer*, a nitrate of copper, and *Brunswick green*, a muriate of copper; together with two or three earths, such as *Italian green, Saxon green*, &c. *Browns* are generally produced by a mixture of *black* and *red;* but there are several earths which yield a brown colour. These are the principal colouring materials employed by the house-painter, for almost every intermediate tint or grade of colour can be produced by mixtures of two or more of the above-mentioned materials, in certain proportions.

The liquid principally employed to mix with these dry colours is *Linseed oil*. This is obtained by beating, pressing, or heating, from the seed of the flax plant, the *Linum usitatissimum*, which grows in most parts of Europe. This oil has so much *fatness* or unctuousness, that it would dry with extreme slowness were not some further precautions taken. It is boiled with *litharge* and *white vitriol*, in certain proportions, by which it has a drying quality imparted to it. *Nut oil* is sometimes used in painting: this is procured from the kernels of walnuts, beech nuts, hazel nuts, and other kinds of nut, by a process similar to that by which linseed oil is obtained. *Oil of turpentine*, or *turps*, is largely used by painters, as it has a drying quality which counteracts the fatty nature of linseed oil, in combination with which it is generally used. It is obtained from a liquid or sap exuding from a species of pine tree, in North America: the sap is crude, or common turpentine; and by a process of distillation, the *oil of turpentine* is obtained from it, leaving a substance behind which constitutes yellow resin. *Oil of spike, oil of lavender*, and *oil of poppies*, are sometimes used by the

painter; but not very frequently, on account of their expense; they are vegetable preparations. *Pilchard oil*, (obtained from the fish,) *common tar*, *coal tar*, and *oil of tar*, are used occasionally for rough exterior work. *Varnish*, *size*, *beer*, *milk*, and one or two other liquids are used to a small extent in some processes to which the painter has to direct his attention. Varnishes are mixtures of various resinous bodies with spirit; and size is a jelly obtained by boiling parchment, leather, parings of hoofs, or of horn, or some similar animal substance, in water.

Preparing the Paint.

Such being the principal materials from which the painter prepares his paint, we proceed to speak of the mode by which he mixes them. The colours are mostly purchased in that form which is called *dry colours*, that is, in coarse powder or small lumps; and they have to be reduced to fine powder before they are mixed with the oils, &c. If they contain gritty particles of sand, &c., the colour is put into a tub or pan, and water thrown upon it, and mixed up with it. The gritty particles soon fall to the bottom, and the remainder is poured into another vessel, where, in a short time, the colouring substance falls to the bottom, and can be obtained by pouring off the water; after which the powder is dried. But if the substance is one which will dissolve in water, or if it is not very gritty, it is ground up to powder in a dry state.

When the substance is reduced to fine powder, the painter begins to incorporate the oil with it. He has a *grindstone* of marble or porphyry, on which he places a small quantity of the dry colour, and moistens it with a little oil. With a large flattened pebble, called a *muller*, he then grinds up the powder with the oil, until both form a perfectly smooth paste. That portion is then removed by a palette knife, (which is a broad thin knife,) and placed in an earthen paint-pot. Another small portion of powder and oil is ground up in a similar manner, and put into the paint-pot; and so on, until a sufficient quantity has been obtained. When this is done, the pot contains paint, which is too thick for use; to liquefy it, therefore, a given quantity, which is determined by experience, of oil or turpentine, or a mixture of both, is added, until the paint has acquired a consistence—thick enough to prevent it from running into drops when laid on the work—and thin enough to make it work with ease.

The Process of Painting.

Supposing the carpenter to have left the doors, the windows,

&c., in a clean and smooth state, the painter's first office is *knotting*. Knots are round places in a plank, in which the grain of the wood runs through the thickness of the board, so as to show the ends of the pores at the surface. These ends absorb a greater quantity of paint than the other portion of the wood, so that if the same number of coats were given to all alike, the knots would have an ugly, dead appearance, in consequence of the absorption. The painter, therefore, gives the knots more paint than the rest of the wood-work; and the preparatory coat, which is laid on the knots only, is called the *knotting*. The paint used is generally red lead, and boiled oil; or sometimes red lead and size. When this knotting is dry, the *priming* is applied, consisting of a thin coat of white paint. White is used for the priming under almost every variety of circumstances, whatever the subsequent colours may be. This white paint is a mixture of white lead, linseed oil, and oil of turpentine, and is laid on, as are the subsequent coats, by means of brushes which are too well known to need a lengthened description. They vary from a quarter of an inch to three inches in diameter, and are generally made of hog's bristles bound round with string, or sometimes with tin.

When the priming is dry, the painter proceeds to fill up all the nail holes and other irregularities, with putty. This he does by means of a pointed knife, with which he works in small portions of putty wherever they may be needed. It is then ready for the second coat of paint, which is thicker than the first, generally white, but sometimes coloured. Painting appears to be a very easy process, but in common with other trades, it requires considerable practice before skill can be attained. After having worked the brush over the wood-work in every direction, so as to completely cover every part with paint, the "laying-off" is effected by drawing the brush smoothly over every part in the direction of the grain, particularly at the stiles and panels of doors. Brushes of various sizes are employed, by means of which the workman can paint the fine mouldings, beading, &c., as well as the broader surfaces. The more skilful the workman is in the use of his tools, the less do the marks of the brush remain visible when the work is done.

As each coat of paint dries, another is laid on, until sufficient has been applied. The number varies from two to seven, according to the part which is to be painted, and the means of those who have to pay the painter; but in general, four coats is the average quantity which new wood-work receives. It is the last two coats only which are of the colour selected, as those which are preparatory are seldom

other than white. On some occasions it is desired to have the last coat *glossy;* but in others *dead.* To effect these differences, all that is necessary is, to vary the oil with which the colour is mixed. If a glossy surface is required, linseed oil is principally used; but if a dead surface, oil of turpentine predominates. It is frequently seen that the walls of staircases, and other large surfaces, are, when finished painting, totally without gloss. This is effected by what is called *flatting*, that is, a coat of paint mixed wholly with oil of turpentine: the turpentine soon evaporates, and leaves the colour without gloss on the walls; whereas, when linseed oil is employed, the oil dries and hardens, instead of evaporating, and assumes much of the character of a varnish. If no linseed oil is employed in flatting, it is called a *dead flat;* but if a little is added, in order to produce a faint gloss, it is called a *bastard flat.* This part of the work forms one of the most unwholesome in which the painter is engaged, since the oil of turpentine, which is constantly evaporating during the process, is found to be extremely prejudicial to health.

As we are here speaking of a *new* house, we need not detail the process followed in repairing an old one. Nor is it necessary so to do even in respect of the processes themselves, for they are nearly the same for old work and new. The principal points of difference are these:—that in old work, greasy and dirty spots are washed with pearl-ash and water, or with turpentine; that the old paint is rubbed smooth with pumice-stone, or, if very rough, burned off; that a smaller number of new coats of paint will suffice; and that a larger proportion of turpentine is used than in new work.

Graining and Marbling.

We have in the above details confined our attention to that more general and economical kind of house-painting in which a large surface is painted of one uniform colour. But the department of house-painting in which the taste of the workman is more fully developed, is that in which imitations of various species of wood and marble are attempted; these processes are called *graining* and *marbling*. We may perhaps call this a humble branch of the *fine* arts, since the workman prepares a *picture* of a piece of wood or of a slab of marble; but whether this be a correct term or not, it is certain that skill in this branch depends more on taste and observation than on fixed rules.

Graining and marbling are sometimes done in oil-paint, but more frequently in *distemper*, that is, with a colour mixed with beer or some other liquid more limpid than oil;

in this latter case, as the graining would not have a durable character, it receives one or more coats of varnish. We will endeavour to give a general idea of the mode in which graining and marbling are effected.

The kind of wood usually imitated in this way is *oak*, or *wainscot*, as it is more generally called. When this is imitated in oil, the last coat of paint previous to the graining is made of rotten stone, white lead, and linseed oil, and is of a light oak colour. On this is laid the graining colour, which painters call the *megilp*, and which is a thin paint composed of oil, rotten stone, sugar of lead, and white wax. When this has set a little, the painter draws over the surface the teeth of a kind of comb, called the *graining comb*, by which an imitation of the grain of oak is produced; these grained lines, to make the imitation more close, are drawn in a wavy direction. The workman then wraps a little piece of leather round the finger, and delicately wipes off the colour from small spots of various forms, by which the light parts of a piece of oak are imitated. In this state, the grain and the light parts have rather a harsh appearance, to remove which, a soft dry brush is worked over the whole in such a manner as to make the various parts blend with one another. A little Vandyke brown is then mixed up into a smooth paint, and with this the dark veins are imitated, by means of a small brush or pencil.

But in graining oak in distemper, the graining colour consists of other materials; many receipts are given, but one is Vandyke brown, burnt umber, and raw umber, mixed into a paint with beer or ale. This is laid on with a brush, and the subsequent processes of producing the grain, the light patches, the dark veins, &c., are much the same as in oil graining, with this exception, that the grain is produced by *veining brushes*, instead of *graining combs*. When the whole is dry, it receives one or two coats of varnish, to act as a preservative.

By processes very similar to that just described, mahogany, rose-wood, satin-wood, maple, pollard oak, zebra-wood, walnut-wood, elm, and other species of wood, are imitated. For mahogany, the ground is Venetian red and white lead, and the graining colour is Sienna, or Vandyke brown, ground in beer. For rose-wood, the ground is lake, vermilion, and flake white, and the graining colour Vandyke brown, ground in ale. For satin-wood, the ground is the same as for light oak, and the graining colour is Oxford ochre, ground in ale. The other kinds of wood are imitated by grounds and graining colours more or less resembling those now mentioned. The manual use of the tools is more difficult for the variegated woods than for oak. Satin-wood, and some other

kinds, have large spots or patches of a lighter colour than the rest of the wood, and of a peculiarly soft appearance; these are imitated by letting a sponge fall on various parts of the wet graining colour, by which some is wiped off, and the edges of these parts are then softened by means of a badger-hair brush, called a *soft even*, which is drawn lightly across the light and dark parts, whereby the sharp edges are softened and blended.

The imitation of marble is effected in a similar manner to that of wood. For white marble, or rather, that which is slightly marked with dark veins, the walls are first white-washed, and then washed with whiting and milk, to obtain a fine white surface. Lamp black, damp blue, Indian red, and some other colours, are then laid on with very fine pencils or brushes, in fine but irregular lines, so as to imitate the veins of the marble. *Sienna marble* has a ground of yellow ochre; *Florentine marble*, one of white, black, and Indian red; *dove-coloured* marble, one of light lead colour; and *black* and *green* marbles have the colours designated by their names. On these grounds are pencilled the light and delicate veins traversing the surface in every direction, according to the colour and character of the veins in the marble to be imitated. There are then various contrivances made use of, by which a softness is produced in all the veins; this is of more importance in marbling than in graining, since much of the beauty which we acknowledge to exist in marble is undoubtedly due to the exquisite softness with which its colours are blended. The kind of marble called *porphyry* is imitated in a singular manner. This marble is spotted all over in various colours; and the imitation is therefore spotted. A ground is laid on of the proper colour, and a brush is dipped into a mixture of vermilion and white, and after being allowed to drain nearly dry, is struck against a piece of wood, by which a sprinkling of small spots falls on the surface. The brush is then dipped into another colour, and a similar process gives a second sprinkling. This is done a third and sometimes a fourth time, according to the colours of the spots in the marble to be imitated. The mica, quartz, and feldspar, in granite, are sometimes roughly imitated by similar means.

Whatever be the kind of marble which is imitated, it is varnished after the marbling is completed, in order both to give it greater durability, and to imitate the beautiful polish which can be imparted to marble.

Gilding, as an Interior Decoration.

Supposing the internal decorations to have proceeded thus

far, we may next say a few words about the costly material *gold*, as applied in furtherance of these embellishments. This is only of limited application, and in the better class of houses; but as gilt mouldings frequently form the finishing part of the papering of a room, and as the houses of most persons contain some articles which are gilt, we will give a slight description of the processes followed by the gilder, but without reference to any particular article of *furniture*, since that is a department into which we do not profess to enter.

A *metal gilder*, or *water gilder*, is a different workman from the *carver and gilder*, who gilds various articles of wood or composition. The former lays a thin coating of gold on articles of metal, by means of mercury and of heat, an employment of an extremely unhealthy character. The carver and gilder lays a surface of leaf-gold on ornaments, frames, or mouldings, made of wood, plaster of Paris, papier-maché, or composition.

If the gold were laid on the bare material by any sort of gum or cement, it would not adhere permanently, nor would it have that brilliancy of appearance which the natural lustre of the metal is calculated to produce; above all, that dazzling surface, known as *burnished* gold, could not be so produced. The gilder, therefore, lays on a certain thickness of such substances as experience has taught him will answer the proposed end. There are, doubtless, many substances which would answer for this purpose; but the course which is actually adopted we proceed to describe.

The Process of Burnish-Gilding.

We will take, as an instance, a long piece of the moulding which the paper-hanger applies in the way to which we have alluded. This is cut out to the proper hollow or reeded form by a carpenter, who employs planes suited for the purpose. The wood which he uses is of a kind tolerably free from knots and holes: and when the moulding is ready, it passes into the hands of the gilder. The first thing done is to wash it with a mixture of whiting and parchment-size, made quite hot, and almost as limpid as water. The size used for this and for other purposes required by the gilder, is obtained by boiling cuttings of parchment in water until a stiff jelly is produced.

When the moulding is dry from the application of this preparatory wash, any small holes that may exist are stopped up with putty, and the moulding is ready to receive five or six coatings of a very thick mixture of whiting and size.

These coatings are laid on moderately warm, by means of a brush, each coat being thoroughly dried before the next is applied. By this means the moulding is coated to the thickness of a sixteenth or twelfth of an inch, by which the fine squares and hollows produced by the plane (if there happened to be such in the moulding) would be liable to be stopped up: to prevent this, modelling tools of various forms are drawn along the wet whiting, so as to preserve the original pattern in tolerable condition. The whole surface is then smoothed by small pieces of pumice-stone worked to fit the various parts of the moulding. The stones and the whiting being kept constantly wetted, and the former worked steadily over the latter, a smooth and even surface is attained.

When the moulding is dry after this smoothing process, it is further smoothed with sand or glass paper, and is then coated with five or six layers of *burnish gold size*. This is a very peculiar composition of suet, black lead, clay, parchment-size, and other ingredients, mixed to a stiff consistency. These successive coats or layers are well dried after each application; and after one or two other processes by which the gold size is rendered smooth, the moulding is ready to receive the leaf gold.

Gold, in the form in which it is thus used, is one of the thinnest substances which the art of man has ever prepared in a solid form, since it would require more than a quarter of a million of the small sheets into which it is beaten, to make a pile *one inch* in thickness. A solid piece of gold is rolled into the form of a ribbon by means of a flatting-mill: and the gold-beater then reduces it to the thickness—or rather thinness—to which we have alluded, by means of hammering.

The gilder receives this leaf gold in the form of sheets or leaves about three inches square, inclosed between the leaves of a small book. He blows out some of these leaves on a leather cushion surrounded by a parchment border on three sides; this border, is to prevent the gold from being blown away, the fourth side being left open for the future proceedings of the workman. The gilder supports the cushion on his left hand, and with a knife in the other, he takes up one of the leaves of gold, and by dexterous management, spreads it out smoothly on the cushion. He then considers the width of the moulding, (which is laid before him,) and determines how he can best cut up the leaf of gold so as to adapt the pieces to the width of the moulding:—if for instance a slip one inch in width will cover the width of the moulding, he cuts the leaf into three equal pieces. He is next provided with a flat camel-hair brush, called a *tip*, the hairs of which are from one to two inches in length, and laid parallel with ~eat regularity.

His tools being thus ready, he wets a small portion of the moulding by means of a camel-hair pencil dipped in water, and, taking the *tip* in his right hand, he lays the hairs on one of the slips of gold, which slightly adheres to it. This slip of gold he transfers to the moulding, where it instantly adheres by means of the water with which the latter is wetted. Another portion is wetted in a similar manner, and another slip of gold laid on, one end of which is made to lap a little way over the one first laid on. A third slip is now laid on in a similar manner; and by this time the first leaf of gold is all used. A second is therefore laid out smooth by means of the knife,—cut into three pieces,—and laid on the moulding as before. This process continues until the moulding has been gilt in its whole extent. We may remark, that the moulding is placed in an inclined position, the higher end being first gilt: this is done in order that the water should gradually flow off from beneath the pieces of gold after they are laid on, to facilitate the drying.

When the gold—or rather the wetted gold size which is beneath it—has attained a certain degree of dryness known only by experience, and which occurs in a time varying from one to twelve hours according to the state of the atmosphere, the gold is *burnished* by means of a burnisher made of flint, agate, or bone. This, if carefully done, produces a brilliant gloss, but could not be at all attained without the layers of whiting and gold size under the gold. Sometimes a portion of the moulding is preferred, for relief and contrast, to be left dead or *matt*, as it is termed. In this case the burnisher is not used; but the gold, after it is dried, is merely secured by a thin clear cement or varnish of parchment size.

The Process of Oil-Gilding.

Sometimes no burnishing at all is required, while a degree of durability which cannot be conveniently obtained with burnish-gilding is desired. In this case the moulding is gilt in *oil gold*, by a process differing in many respects from that which we have mentioned.

For oil-gilding a ground of whiting and size is required, as in burnish-gilding, but not in so great quantity. After the application of a few coats of whiting and size, the moulding is smoothed in the manner before described; and in some cases a few coats of burnish gold size are applied, but not always. The next process is to wash the moulding with two or three coatings of strong size, by which it acquires a gloss somewhat similar to that produced by varnish, and which has

the effect of preventing the absorption of the substance next employed.

The moulding is now ready to receive the *oil gold size*, which is an exceedingly smooth mixture of ochre and oil. This is laid on in a stratum as thin and smooth as possible; and after being set aside for some hours, it acquires a peculiar degree of clamminess between wet and dry; when it is ready to receive the coating of gold. The gold is blown into the cushion, spread out, cut into slips, taken up by the tip, and applied to the work, in the same manner as in burnish-gilding; but the moulding is not wetted with water, the partially dry oil gold size serving that purpose. The gold is, in this case, pressed down into the hollows and crevices of the moulding, by means of a piece of cotton wool; and when the whole is gilt, a soft brush is lightly applied, by which the gold is worked into small depressions, which it would not otherwise have reached, and the superfluous gold is rubbed off. The gold is now left as it is, or is washed with transparent size, or receives a coat of varnish. In either case it becomes in a short time so far hardened as to be susceptible of washing without being rubbed off.

Gilding Enriched Ornaments.

The description which has been given of the process with reference to the mouldings used by the paper-hanger will also apply to most other articles with which the gilder is concerned. But in proportion to the elaborate nature of the article must be the care bestowed by the gilder. This particularly applies in the case of an elegant carved looking-glass frame.

The richly ornamented frames, window-cornices, mouldings, &c., which form a great part of the work of the gilder, are in general not carved in wood, but are cast in moulds, and are made of a tough and durable composition formed principally of glue and whiting. The ornaments, when cast, are fixed on wood frame-work or foundation, and in that state pass into the hands of the gilder. His mode of treating them is somewhat different from that required by a straight plain piece of moulding:—the material itself does not require so many layers of whiting and size as those articles which are made wholly of wood; and the difficulty of smoothing intricate and ornamental surfaces renders many precautions necessary.

Sometimes the cornice of a room, or a portion of it, and also the central ornament of the ceiling, are gilt. This is generally done in oil gold; and as the material of which they

are made, viz., plaster of Paris, very much resembles whiting, scarcely any of the last-mentioned substance is required to be applied by the gilder.

We may here state, in connexion with what has been said about gilt mouldings for rooms, that the paper-hanger fixes them to the wall by means of broken needles, or headless brittle needles made for the purpose. The pieces of moulding are cut to the required length, and mitred, so as to join accurately at the corner; after which they are fastened to the wall by driving in some of the needles at distances of two or three feet.

Chapter XI.

A MODEL DWELLING-HOUSE.

The late Sir John Robison's House at Edinburgh.

The various contrivances for rendering a dwelling-house complete in all that respects the comfort of the inmates, could not perhaps be better illustrated than by taking some actual instance, and showing what has really been effected. The late Sir John Robison, an enlightened man of science at Edinburgh, erected a house in the north-west part of that city, and fitted it up with a care which has been rarely observed in other places. So much has this house been regarded as a model, that a full description of it has been given in the Supplement to Loudon's *Encyclopædia of Cottage and Villa Architecture;* and we propose to give an abstract of such portions of this description as can be understood without the aid of elaborate drawings.

The distribution of the internal space of the house is so managed, that, with the exception of two partitions in the first chamber-floor, which cross the floors without resting on them, all the internal walls reach from the foundation to the roof. The two partitions here mentioned are of stone, and are supported on cast-iron beams isolated from the floors, the joists of which are supported by wooden beams placed alongside, but not connected with the iron beam. The movements of the flooring, therefore, are not communicated to the partitions, and do not consequently affect them by vibration.

The arrangement of the rooms, staircases, and passages, has especial reference to the ventilation of the whole house. While the mass of air in the rooms and passages is constantly undergoing renewal by the escape of the vitiated air above, and the admission of large supplies of fresh air from below, no currents are perceived in the apartments, which, even when crowded with company, and amply lighted, preserve a remarkable degree of freshness. Cylindrical flues of earthenware, nine inches in diameter, are built into the gables, in close proximity to the smoke flues of each room; and the lower ends of these ventilating flues open into the spaces between the ceilings of the respective rooms and the floors of those above them; and there is one or more of these exit air-flues in each room, according to its size and use. The heated and vitiated vapours pass upwards through the ceiling by a continuous opening of about one inch and a half wide (behind

one of the fillets of the cornice) all round each room; and having thus passed into the space between the ceiling and the floor immediately above, they ascend by the flues in the wall, and are discharged by them into the vacant space between the ceilings of the attics and the roof, from whence they find their way through the slates to the open air. The passage for the air through the cornice is not visible from the floor of any of the rooms, an ornamental moulding being so arranged as to conceal it. The air flues are made to terminate above the ceilings of the attics, and below the roof of the house, rather than at the chimney heads, in order to prevent the possibility of smoke being ever brought down by reverse currents; and an advantage is likewise gained in protecting the attic story from the cold which would otherwise be communicated from the roof during winter.

The continued supply of fresh air to the lower part of the house, to replace that which is carried off by the ventilators and by the chimneys, is brought in from the garden behind the house by a passage, the sectional area of which is eight square feet. The cold air admitted by this passage (or by another similar one from the front of the house) is made to pass over a stove in a lower chamber having a surface of nearly ninety square feet, so that a temperature of from 64° to 70° Fahr., can thus be imparted to the air. In very cold weather, 70° is occasionally given to compensate the cooling effect of the walls and glass windows, so as to preserve an equable temperature of 60° throughout the house; but the usual temperature of the air issuing from the stove is as low as 64°. The whole of this air is discharged into the well of the staircase, which forms a reservoir from whence the rooms draw the quantity required to maintain the upward currents in the chimneys and in the ventilating flues. The air in the staircase finds its way into the apartments by masked passages, of four or five inches wide, and four feet long, over the doors, and by openings an inch in width left under each door. The sectional areas of these passages are more than equal to the areas of the chimney and ventilating flues; there is, therefore, no rarefaction of the air within the rooms, nor any tendency of the external air to enter at chinks of windows or other irregular apertures. The course of the air, from the great aperture over the stove, through the staircases, over and under the doors, into the rooms, thence through the ceilings, and upwards by the escape flues, forms a continuous series, in which all the air for all the rooms comes from one central point, and is raised at that centre to the precise temperature required. The quantity of escape is regulated by hand, by means of throttle-valves at the mouth of each escape

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flue; hence, by opening or shutting each throttle-valve, the rate of the ventilating current is augmented or diminished.

The kitchen is ventilated on the same principle as the upper rooms. One flue proceeds from the ceiling over the fire-place, and another from over a gas-cooking apparatus. The first of these is built in the gable, close to the smoke flue; and the second passes up near the back of the water cistern, so that the constant ascent of the warmed air may by its vicinity prevent the water in the cistern from freezing in the winter.

The house is lighted by gas in every part; but no offensive vapour or inconvenience of any kind appears ever to be felt from it. The distribution pipes are of greater diameter than are generally employed, and the pressure or current is thereby so equalized, that no sinkings or flutterings of the flame are caused by the opening and shutting of doors. The forms and proportions of the Argand burners and glass chimneys are also so arranged as to effect nearly a maximum development of light (of an agreeable hue) from the gas, and to prevent any disengagement of sooty vapour; and the white and gold ceilings of the drawing-room are said to attest the complete success with which this latter object has been attained. The mirrors over the chimney-pieces have statuary marble frames, and each chimney-piece has two gas lights. But the use of gas in the kitchen is perhaps the most remarkable. Here there is a *gas-cooking* apparatus. In the application of gas for cooking, the arrangements are generally as follow:—A metallic ring, pierced on its upper side with a great number of holes of very small size, is attached to the pipe communicating with the gas main, and is placed within a double drum or cylinder of iron, raised an inch or two from the floor on short legs. This double cylinder is so constructed as to leave a space between the inner and the outer cylinder of about two inches; and in this space near to the bottom, the pierced ring is fixed. A stop-cock in the pipe connecting the pierced ring with the gas main shuts off the supply of gas when the stove is not in use. On opening the cock, and applying the gas to the pierced ring, a brilliant ring of flame is immediately produced, which soon heats both cylinders. The air within the inner cylinder ascends into the room, which it helps to warm; the outer surface of the outer cylinder also performs a similar service; while the space between the two cylinders contains the products of combustion, which are allowed to escape into the room, if the heating power of the whole is required; but which are carried off by an inclosed channel, if it be wished to protect the air of the room from deleterious mixture.

In this house, the gas-cooking stoves are eight in number, the mouth of each being four inches in diameter, a size which experience has shown to be the most useful. The kitchen fire-place is no larger than is requisite for roasting; all the other processes being performed either in the oven, the steaming vessels, or at the gas stoves. These stoves are placed in the bay of a large window, thus giving the cook the advantage of a good light above the level of the pans. A close boiler at the back of the grate affords steam for the cooking utensils and for a hot closet; it also contains a coil of iron tubing, through which the water of a bath, placed in a dressing-room on the chamber floor, is made to circulate when a hot bath is wanted.

The flues for carrying off heated vapours, &c., are of two kinds. It has already been stated, that the vitiated air of the rooms is conveyed by apertures just below the ceiling into pipes which find an exit at the top of the house. These flues are made of cylinders of red earthenware, eight or nine inches in diameter. Those by which the smoke of the fires is carried away, are cylinders of fire-brick clay, from two to three inches thick, and from seven to ten inches in diameter. In each fire-place, where the throat of the chimney is contracted over the grate, there is a valve made of rolled iron plate, which fits into a cast-iron seat fixed in the brick-work; when this valve is in its seat, neither soot nor smoke can pass; and when it is thrown back, the passage to the flue is unobstructed.

After describing the mortise locks for the doors, and the arrangements of some French windows for opening into a balcony, both of which exhibit ingenious and novel features, Mr. Loudon quotes a letter from Mr. Hay, of Edinburgh, the author of a *Treatise on Harmonious Colouring*, and who superintended the interior decorations of the house. The drawing-rooms are first spoken of thus:—The walls have been prepared with several coats of white lead, grained to imitate morocco leather; on this a pattern of gilded rosettes has been laid, and the whole varnished with copal. Another pattern has then been superadded in flat white, so that the whole has been compared in appearance to a lace-dress over satin and spangles. Mr. Hay says: "There is nothing very much out of my usual practice in the painting done in Sir John Robison's house in Randolph Crescent, except the walls of the drawing-rooms and staircase. The bed-rooms were done in the usual way; namely, ceilings sized on two coats of oil paint; walls papered with a white embossed satin-ground paper, with small brown sprigs; and the wood-work painted white, and finished with copal varnish. The dining-room and

Sir John's own room were both done in imitation of wainscot, with white ceilings, varnished. The staircase ceilings and cornices painted white and flatted; and the walls and wood-work painted also white, and varnished with copal. The drawing-rooms and ante-rooms were all painted white; the ceilings and cornices, as well as the wood-work, being finished flat, and heightened with gilding. The walls are, as I have already said, rather peculiar in their style of painting. The ground work is rendered regularly uneven by being granulated—by working it over with the point of a dry brush, immediately applying the two last coats of paint. This is partly varnished and partly flat, the flat parts forming large rosettes. Between these rosettes are smaller ones, gilded, not in the base-metal used upon paper-hangings, but in sterling gold leaf. This style of decorative painting, from the great body of paint employed in producing the granulated surface, the copal varnish, and the gold leaf, must be of the most durable description. I may here mention, that during the last two or three years, I have painted a very great number of drawing-rooms in various styles, some with rich borders, others in my patent imitation of damask, and a few in styles similar to that employed upon Sir J. Robison's; and have papered very few. I feel very sure, that as the advantages of painting over papering, especially in the public rooms of a mansion, become generally known, the latter style of decoration will be entirely given up. As to the colouring of ceilings, that must be left in a great measure to the taste of the proprietor; as some like pure white, others delicate tints, and a few go the length of the most intense colours, or polychrome. With this last class I myself agree; but I am at the same time aware, that if this be not done with the most strict attention to the laws of harmonious colouring, the effect must be bad; it would be like a person unacquainted with the science of music, running his fingers at random over the keys of a powerful organ. In the one case, white, or a light tint, is better than colours; and in the other, silence better than such an attempt at music."

A Beau-ideal English Villa.

The work from which the above has been derived, viz., LOUDON'S *Encyclopædia of Cottage, Farm, and Villa Architecture,* contains a chapter contributed by an anonymous writer, but devoted to a singular and interesting subject. The object is to lay down rules for the construction and furnishing of a villa which should be the *beau-ideal*—the standard of excellence—of this class of dwelling-house. He describes

the characteristics of the old English country-house; and, taking that as his model, shows how modern improvements may be brought to bear on the general arrangements of the building. The description is too long to be given here in full, even if it were right so to do; but we will condense into a few paragraphs those details which relate to the construction and fittings of the house, omitting all those matters which relate only to furniture.

The residence here described, or rather imagined, is the country house of an English gentleman of ample means, but partaking much more of the *manorial* than of the palatial character. The term *villa* is not perhaps so fixed in meaning as to convey to every one the same idea of the kind of building alluded to. The word was originally used by the Romans to denote a farm-house, with the offices requisite for the accommodation of a husbandman. Afterwards, when luxury increased, the term *villa* was applied to the country residence of an opulent Roman citizen. It is in a somewhat similar style that the word is here to be used.

The villa being a place of agreeable retirement, but not one of seclusion from the world, it should be situated within reach of a public road, at an easy distance from the metropolis. "I should prefer a situation removed about a mile from the great public road, and about ninety miles or a day's journey from the metropolis. Here I would inclose a park of 100 or 150 acres; bounded on the north and west sides by lofty wooded hills; on another side by a road; and elsewhere by the inclosed country of the district; the surface of the park varied, but gently inclining to the south, with a rapid stream of water passing through it at no great distance from the site of the house."

A villa (the writer proceeds to say) should always form part of a village, and be placed if possible on rather higher ground. The old English style of architecture is preferred; as being more picturesque and ornamental; as according best with rural scenery; as, by admitting great irregularity of form, it affords space for the various offices and conveniences necessary in a country house; and as being better suited to our climate than the Grecian style, which, by requiring porticoes, projecting cornices, and windows of rather small size, tends to intercept the light and make the house gloomy. The old style also allows more variety of ornament upon the roof, such as the stacks of chimneys, gables, pinnacles, turrets, and other appendages to the general effect of a building when seen at a distance; whereas in the Grecian style, which requires perfect symmetry of form, and the prevalence of straight lines, these arrangements could not be admissible.

For these reasons an old English or "Elizabethan" house is selected. The front of the house would present a centre and two projecting wings. The centre would contain the hall and dining-room, with a gallery and staircase behind them. One wing would be occupied by the drawing-room and library, with the saloon between them. The other wing might contain a sitting-room, and superior offices for servants; the inferior offices being on the basement, or in a separate building in the kitchen-court. The principal part should be highly ornamented, and form a symmetrical whole. In the centre would be the porch of two stories, with its rich gable, small pillars, escutcheons, &c.; the wall on either side (broken into compartments by pilasters, or handsome buttresses, and proper string-courses) would contain large mullioned windows; the whole supporting a battlement or parapet, with its appropriate ornaments. The ends of the projecting windows would present each a bay window of two stories, square or semicircular in form, with balustrade or stone covering above; the gables of the wings corresponding with that of the porch. The high and steep roof should be varied by ornamental chimneys of different patterns, placed in their proper situations; and, rising above them, the tower, containing the grand staircase, appearing at a short distance behind the porch; its waving cupola roof terminating in a rich lantern, and supporting a weathercock or dwarf spire.

After giving his reasons for thinking that a country residence in the Elizabethan style should have a kind of rich framework of courts and gateways, balustraded terraces, and architectural gardens, the writer proceeds to describe the interior of his supposed edifice, beginning with the *porch*. This should be ascended by a flight of stone steps; it should be floored with stone; and the ceiling, the door, and the doorway, highly enriched.

The entrance-hall, which succeeds the porch, would vary in its character according to the size of the house. In the large old English mansions it was formerly the dining-room and place of rendezvous for the servants and retainers; but in a smaller house, such as might be termed a villa, and especially under the altered habits of English society, a smaller hall, and one more nearly resembling a mere entrance, would be fitting. An English hall admits of much picturesque embellishment, such as a carved oak roof or ceiling, either flat or semicircular, enriched with highly-wrought bosses or coats of arms; a music gallery across the end, supported by pillars or a carved screen; a chimney-piece reaching to the cornice of the roof; and a carved wainscot covering half the height of the walls.

Having entered the porch-door, and crossed the lower end

of the hall, entrance would be gained to the *gallery*, a sort of an in-door promenade, between the hall and the staircase; having one door leading to the saloon, another to the billiard-room, and another to the domestic offices. "The staircase is an important convenience in every house; and it should always be a striking feature in a mansion of any elegance. The tower, which I suppose to contain the staircase, would be square, as high as the ceiling of the upper floor, where it would take a sort of octagon form; the roof coned, and ending in a lantern: in the centre of the lantern a boss would support a lamp. In the side, opposite to the arch by which you enter, would be a tall mullioned window filled with stained glass. Advancing a few steps, you would reach the first flight in the middle of the tower, and ascend to the first landing-place; you would find a flight of stairs on the right and left leading to the second landing, in the centre of which is the upper gallery door, immediately over the arch below. As the house is to be in the old English style, the stairs might be either of oak or stone; but the balusters must be of oak handsomely carved, and rather heavy. They might begin at the foot of the stairs with a richly-carved sort of pedestal, and the same at each corner as they ascend. In old staircases there was frequently an animal of some sort sculptured in wood, supporting the family arms, placed on these pedestals, especially at the foot of the stairs; or the animal had a substitute in a ball or pine-apple."

The chief apartments on the ground floor are described as being the saloon, the drawing-room, the library, the dining-room, and the study. The saloon is generally a sort of vestibule to the dining-rooms; and, supposing it to be such in this case, and of a parallelogram form, its arrangement is thus sketched:—The entrance door is in the centre of the side next the gallery; in the centre of the end on the right hand would be the drawing-room door, and in the centre of the other end the library door. On the other side should be two windows, with a glass door between them opening to the terrace and garden. The drawing-room would be larger than the saloon. On entering from the saloon the opposite end would present a square or circular bay-window, commanding a view of the park and the distant country beyond it. On the right side would be the fire-place, and on the opposite side two windows looking over the terrace.

Crossing the saloon from the drawing-room we should arrive at the library. This would be about the same size as the drawing-room, and would, like it, have a bay window opposite the entrance, and two other windows opposite the fire-place. This room, it is supposed, would be the family

sitting-room when there is no company in the house; and would be the forenoon resort of the gentlemen when guests are stopping at the house; and hence arises a very minute and curious detail of the manner in which the library should be fitted up, in order to answer this double purpose. These, however, we cannot enter upon; but the following will give an idea of the manner in which this imaginative house-builder fills up the rooms of his villa:—"As to the smaller ornaments to be placed around the room, they should be curious and interesting, and on no account frivolous. Handsome silver inkstands, a few curious fossils, or models of celebrated buildings; all sorts of writing-cases and implements, taper stands of silver, boxes of coins, old china in large jars, and anything of these kinds, with handsome books, might decorate the tables; and, as nothing gives a room a more dismal effect than an appearance of idleness, everything should be so arranged, both here and in the drawing-room, as if the persons using the rooms had been employed in some way or other. This effect would be produced by the daily papers, and some periodical works, and open letters received in the morning, on the principal tables; and, on other tables, some of the blotting-books might be open; the inkstands not thoroughly in order, with some unfinished writing and open books or portfolios, would give at least the appearance of industry. I do not recommend such foolish tricks, which are, I know, often used by idle people, who have sense enough to feel the bad taste of indolence; and in a sensible family, who spent their time rationally, this would be, in fact, the usual state of the room, at least during the morning."

The dining-room of the *beau-ideal* villa is contiguous to the hall, whence entrance is obtained by double doors. The walls are covered with old oak wainscot. The fire-place should be very large, reaching nearly to the ceiling, and all the fittings and arrangements of a massive, solid, and handsome kind. The gentleman's study, or business room, would be a smaller, plainer, and more strictly private room, on the same floor, and used for writing, reading, and transacting business.

Having disposed of the principal apartments, the writer proceeds to describe the rooms on the next floor above, occupied chiefly as bed-rooms. The grand staircase leads up to a second gallery, over the lower one; and in this gallery are the doors of all the best sleeping-rooms. The sitting and sleeping nurseries are also on this floor; as is likewise the governess's sitting-room, "in a quiet part of the house." The bed-rooms for the servants are on the upper floor, approached by the back staircase.

Then we descend to the basement of the house, where the various servants' rooms are situated. The housekeeper's room should be a spacious comfortable room, furnished as a respectable parlour; and so situated that the other offices may be overlooked by the housekeeper. A door in this room should open into the still-room, which is the common sitting-room of the under female servants, and where portions of the ordinary operations are carried on. A store-closet opens conveniently into the still-room, and has conveniences for arranging the stores and provisions as they are unpacked. The butler's pantry, being the room in which the plate is lodged, should be placed in a part secluded from the back entrance to the house, and should have strong doors and window-shutters to prevent depredation. The servants' hall would be near the back entrance to the house, and easy of access. Here all the under servants would dine, and it would be the common sitting-room for the males. The larders, if the house were large, would be four in number; the wet larder for undressed meat, the dry larder for cold meat, the game larder, and the pastry.

The kitchen, as being one of the most important rooms in a hospitable mansion, is treated with due importance. The writer describes the arrangements in the kitchen of a mansion in Warwickshire, as being fitted to serve as a model. "The kitchen, scullery, larder, &c., formed a range of building on one side of the kitchen-court, separate from the house, but there was a covered way between them. The building was of two stories, the kitchen occupying the centre. It was a large lofty room, of good proportions, as high as two stories of the building. You entered it at one end, by large folding-doors, from a passage through the building; at the opposite end was the fire-place, with the screen before it; on one side of which was the door to the scullery and bakehouse, on the other a range of set coppers of different sizes. On one side of the room were two rows of windows, and under the lower row a range of charcoal stoves and hot plates: the latter to keep things warm. The other side had only the upper row of windows, and against the wall was a dresser, above which the copper cooking utensils, &c., were ranged in a very ornamental way. A long table was in the centre of the room, and over the door a dial-clock. The ceiling had a very handsome cornice, and a boss in the centre, from which hung a brass lamp. Opposite the entrance door another door admitted you to a passage, on one side of which were the larders, on the other salting-rooms, &c.; and at the end a staircase led to the cook's apartment over. There was a sort of turret in the

centre of the roof, containing a capital clock, which struck upon the dinner bell. The other offices were in the basement of the house, and the kitchen was detached, to prevent the annoyance of the smell of cooking, which commonly ascends from a kitchen beneath the house. I thought the arrangement particularly convenient, and the kitchen was really an elegant apartment. As, in a large establishment, there is cooking going on through the whole day, it is of importance to the comfort of the family, to place the kitchen in such a situation that the smell of cooking, which is particularly offensive, may not be an annoyance to the principal apartments. A house with the kitchen in the basement story is generally subject to this inconvenience, and it is usually avoided by having the kitchen and offices in a separate building adjoining the house."

The writer continues his remarks and descriptions in a similar manner, treating of all the various parts of the building in succession; then of the riding-house, the stable-yard, the coach-houses, the harness and saddle rooms, and the dog-kennel; then of the kitchen garden, the pleasure garden, the dairy, the farm buildings for a "gentleman farmer;" and, lastly, of the village and the village church, so far as regards the relation between them and the mansion. In short, this writer seems to have proposed to himself this question—"What are the excellencies to be desired and attained in the mansion of an English country gentleman?" and he appears to have solved it by putting together the scattered fragments of his experience in various quarters, and building up an ideal mansion therefrom.

Chapter XII.

FIRE-PROOF HOUSES.

The attempts which have been made to render houses fire-proof are so intimately connected with the construction of dwellings, that it will be proper to give a few brief details on the subject. There are many difficulties attending these attempts; for so long as wood forms the chief inner frame-work of a house, there will always be considerable liability to destruction by fire. Most of the proposed plans have had relation to the coating of the wood with some substance which should render it less inflammable, while others have been directed rather to the rejection of combustible substances from the list of those used in house-building.

So long back as 1775, Mr. Hartley made several trials in order to test the efficacy of a method invented by him for that purpose. Thin iron plates were nailed to the top of the joists; the edges of the sides and ends being lapped over, folded close, and hammered together. Partitions, stairs, and floors were proposed to be defended in the same manner. The plates were so thin as not to prevent the floor from being nailed on the joists in the same manner as if the iron were not used; and the plates were kept from rust by being painted or varnished with oil and turpentine. Mr. Hartley had a patent for this invention; and Parliament voted a sum of money towards defraying the expense of his numerous experiments. It does not, however, appear that the plan was permanently adopted.

About the same period, Lord Mahon, afterwards Earl Stanhope, a nobleman possessing a highly inventive tact in mechanical matters, brought forward another method having the same object in view. This method was of a three-fold character, comprising *under-flooring*, *extra-lathing*, and *inter-securing*.

The method of under-flooring is either single or double. In single under-flooring, a common strong lath of oak or fir, about one-fourth of an inch thick, should be nailed against each side of every joist, and of every main timber, supporting the floor which is to be secured. Other similar laths are then to be nailed along the whole length of the joists, with their ends butting against each other. The top of each of these laths or fillets ought to be at an inch and a half below the top of the joists or timbers against which they are nailed; and they will thus form a sort of small ledge on each side of all the joists. These fillets are to be well bedded in a rough

plaster when they are nailed on, so that there may be no interval between them and the joists; and the same plaster ought to be spread with a trowel upon the tops of all the fillets, and along the sides of that part of the joists which is between the top of the fillets and the upper edge of the joints. In order to fill up the intervals between the joists that support the floor, short pieces of common laths, whose length is equal to the width of these intervals, should be laid in the contrary direction to the joists, and close together in a row, so as to touch one another; their ends must rest upon the fillets, and they ought to be well bedded in the rough plaster, but are not to be fastened with nails. They must then be covered with one thick coat of the rough plaster, which is to be spread over them to the level of the tops of the joists; and, in a day or two this plaster should be trowelled over, close to the sides of the joists, without covering the tops of the joists with it.

In the method of double-flooring, the fillets and short pieces of laths are applied in the same manner as here noticed; but the coat of rough plaster ought to be little more than half as thick as that in the former method. Whilst the rough plaster is being laid on, some more of the short pieces of laths must be laid in the intervals between the joists upon the first coat, and be dipped deep in it. They should be laid as close as possible to each other, and in the same direction with the first layer of short laths. Over this second layer of short laths there must be spread another coat of rough plaster, which should be trowelled level with the tops of the joists, without rising above them. The rough plaster may be made of coarse lime and hair; or, instead of hair, hay chopped to about three inches in length may be substituted with advantage. One measure of common rough sand, two measures of slaked lime, and three measures of chopped hay, will form in general a very good proportion, when sufficiently beaten up together in the manner of common mortar. The hay should be put in after the two other ingredients are well mixed up together with water. This plaster should be made stiff; and when the flooring boards are required to be laid down very soon, a fourth or fifth part of quicklime in powder, formed by dropping a small quantity of water on the limestone shortly before it is used, and well mixed with this rough plaster, will cause it to dry quickly. If any cracks appear in the rough plaster work near the joists, when it is thoroughly dry, they ought to be closed by washing them over with a brush wet with mortar wash: this wash may be prepared by putting two measures of quicklime and one of common sand into a vessel, and stirring the

mixture with water till the water becomes of the consistence of a thin jelly.

Before the flooring boards are laid, a small quantity of very dry common sand should be strewed over the plaster work, and struck smooth with a hollow rule moved in the direction of the joists, so that it may lie rounding between each pair of joists. The plaster work and sand should be perfectly dry, before the boards are laid, for fear of the dry rot. The method of under-flooring may be applied to a wooden staircase, but no sand is to be laid upon the rough plaster work. The method of extra-lathing may be applied to ceiling joists, to sloping roofs, and to wooden partitions. The third method, which is that of inter-securing, is very similar to that of under-flooring; but no sand is afterwards to be laid on. Inter-securing is applicable to the same parts of a building as the method of extra-lathing.

Such is a general outline of the modes proposed by Lord Mahon for rendering houses fire-proof; in which it will be seen that the safeguard consists in the use of a non-combustible material, with, and among, and between the pieces of wood forming the frame-work of a house.

The more recent attempts to gain the same object by means somewhat similar have been very numerous; some of which we may here notice as examples of the whole.

An American patent was granted in 1837 to a Mr. Louis Pambœuf, for the invention of a fire-proof paint. The mode of preparing it is thus described. A quantity of the best quicklime is selected, and slacked with water in a covered vessel; when the slacking is complete, water, or skimmed milk, or a mixture of both, is added to the lime, and mixed up with it to the consistence of cream. When milk is not used a solution of rice paste is employed, obtained by boiling eight pounds of rice to every hundred gallons of paint. When the creamy liquor is prepared, alum, potash, and common salt are added, in the proportion of twenty pounds of alum, fifteen pounds of potash, and a bushel of salt, to every hundred gallons of the paint. If the paint is to be white, six pounds of prepared plaster of Paris and the same quantity of fine white clay are added to the above proportions of the other ingredients. All these ingredients being mingled, the mixture is strained through a fine sieve, and then ground in a colour-mill.

When roofs are to be covered, or when crumbling brick walls are to be coated, fine white sand is mixed with the paint, in the proportion of one pound to ten gallons of paint; this addition being made with a view to giving the ingredients a binding or petrifying quality. In applying this paint,

except in very warm weather, it is prepared in a hot state; and in very cold weather precautions are necessary to prevent it from freezing. Three coats of this paint are deemed in most cases sufficient.

In another variety of this paint oil is the chief liquid ingredient. To prepare it forty gallons of boiled linseed oil are mixed with slacked lime to the consistence of a paint; and to this are added two pounds of alum, one pound of potash, and eight pounds of common salt; or good wood-ashes may be substituted for the potash. This paint is used in the same manner as other paint; and any colour may be obtained by adding the usual pigments to the composition.

The preparation of a kind of paint containing alkalies seems to have been a favourite measure among inventors of "fire-proof" composition; for many of the modern projects have had this for its basis. But in most cases there have not been means for determining the degree of efficacy possessed by these compositions. There were, however, a few years ago trials made of rather an interesting character, which were described in the public journals, and which were of the following nature.

In 1838, a company was formed for the sale and use of a composition of this kind, and an experiment was made in the Clapham Road to show its efficacy. The house, which was a small one, had been built in the usual way, with the intention of being fitted up in the ordinary style. While yet a mere shell, all the boards, timbers, floors, ceilings, stairs, and wood-work generally, were coated thickly with a greyish or slate-coloured composition, which dried to a state of great hardness.

On a particular day the upper floor was covered with shavings in great abundance, to which a number of deal planks were subsequently added. The first floor front room was fitted up as a chamber, with bed and furniture, chairs, tables, &c., as nearly as possible in the usual style. The shavings and wood on the upper floor were then kindled, as were also planks and shavings placed on the floor of the furnished room. The consequence of this was that the two rooms speedily exhibited a blaze of light: the whole of the furniture (purposely selected of an inexpensive kind) being ignited. The flames burst from the windows; but although the entire contents of the room were consumed, the fire did not communicate to the floor above, nor to that beneath, nor even to the other room on the same floor. Several small parcels of gunpowder were introduced between the ceiling of the burning room and the floor of the room above it; but

they did not ignite; nor were the other parts of the house injured in any material degree.

Another trial took place at the White Conduit Gardens; where two close wooden buildings, of the size and shape of sentry boxes, were placed in the grounds. One of them was coated on the inside to the thickness of about an eighth of an inch with the composition, and was also partially covered on the outside; while the other was left in the plain wood state. A flooring was placed at about the centre of each of these, and through the holes in front shavings were put and then ignited. The box which was not coated with the composition was soon in flames; while the fire in the other went out without having had any effect upon the general structure. The building which was in flames was then placed contiguous to the partially-coated outside of the other, and although it was not materially injured, the exterior coating peeled off in some places, and the wood became charred; the interior, however, appeared perfectly uninjured by the flame.

If the results of these experiments were really such as the description would seem to imply, it might excite surprise how it happens that no practical results have followed. But there are always numerous reasons why an experiment, which succeeds under circumstances *made* for the occasion, should not be available in practice; and it is probable that some such discordance may exist here. Perhaps the mode in which we may more consistently look for the practical attainment of the object in view is by the adoption of some improved mode of building, in which either wood is not employed at all, or, where sparingly used, measures are taken to shield it from the action of fire. One such method is Leconte's, described as follows.

This plan consists in the employment of iron frames to receive concrete matter for forming the walls. The basement story of the building is constructed according to the ordinary methods up to one foot or more above the ground. On the basement so constructed is to be erected the patent wall, formed of frames entirely of cast-iron, in one or more pieces, or a combination of cast-iron and wrought-iron plates. These frames are to be set one on the other until the required height is attained, the necessary stability being obtained by means of steady pins at the corners of one frame fitting into holes made in the corners of the frame which is opposed to it. Suitably-shaped frames are employed for the internal partition walls, and for doorways, window-frames, &c. The flues of the chimneys are formed of iron or other metal pipes, placed in the thickness of the walls. When the required elevation is obtained, a concrete of any suitable material is

poured into the framing, and fills up the vacant space, giving firmness and solidity to the structure; the concrete being made of gravel and lime. To give steadiness, lead is to be introduced between the joinings of the iron-work. The doors and window-frames are to be fastened to the walls by any of the usual known methods. The main beams and cross beams of floors and roofs may be of cast-iron, or formed of iron and wood; or they may be formed of one or more pieces of plate-iron, bent up into an oval form, and straightened by an iron or wooden bar passing through them lengthwise, the upper edges of the metal being turned over to increase the strength. In the interval between the beams there are to be iron rods running in various directions, and supporting a metallic wire-work, which forms the foundation for the ceiling. Similar wire-work is to be employed in lieu of laths for all plaster surfaces. All the iron-work is to be painted over with some suitable composition to prevent oxidation.

A plan for the same purpose has been proposed by Mr. Varden as follows:—"It appears probable that common fir or oak joists with their lower edges chamfered, and coated over with a mixture of alum, black lead, clay, and lime, or some similar composition, would (if closely floored above with earthenware tiles, bedded all round into the plastering, the joists being made air-tight) resist the action of flames, at least for a considerable time. Fire could not descend through such a flooring so as to communicate with the rooms below, till the tiles used in it had become red-hot; neither could it ascend until the tiled floor above gave way, from the burning of the joists; which, if coated as proposed, would not take fire from below till the tiling over them acquired a sufficient heat to cause the distillation of the turpentine from the wood. In general, there is not furniture enough of a combustible nature in any room to do this. The battening against the outer walls might be of larch, as that wood burns less freely than most others; but if the walls were brick, or lined with brick, battening of any kind will be unnecessary. If this plan should be thought likely to answer the end proposed, houses built in the common manner might be altered at a moderate expense, by taking up the boarded floors, and substituting earthenware tiles."

Another plan, proposed by Mr. Frost, consists in forming the floors of rooms of hollow earthenware tubes embedded in cement, combined so as to form a sort of flag-stone, covering the whole floor. These hollow tubes are square in section, about an inch and a half on the side externally, with a tubular space of an inch and a quarter on the side internally; they are formed of brick earth, prepared in a superior manner,

and pressed through moulds by machinery; and their length is about two feet. In forming a floor of these tubes, the centering, after being prepared and fixed in the usual manner, is first covered with a coating of cement of a quality sufficiently fine to form the ceiling of the apartment to be floored over; and if it is desired that there should be mouldings or ornaments in this ceiling or its cornices, moulds for them can be placed in the centering, so as to form a part of it. One or two coats of cement having then been laid over the centering, a stratum of the square tubes laid side by side, and breaking joint, is next embedded in fine cement, and the interstices between them also filled in with that material. One thin coating of cement is then laid over the whole stratum; and in a week, when this is dry, another stratum of tubes is laid over the first in a contrary direction, bedded and filled in with cement as before, and finished by a coating of the same material. This, when dry, may have a second coating to serve as the floor of an upper apartment, or the covering of a roof, as the case might be.

Mr. Loudon gives descriptions of two methods, the one for building houses in general fire-proof, and the other for imparting that property to houses already built. He considers the two main points for consideration to be, to have staircases of iron or stone, or both combined, and to avoid having any hollow partitions or floors. A house having a stone or iron staircase, and having all the partitions either of four-inch brick-work, or of brick nogging, in whatever way it might be set on fire, could hardly be burned down, if ordinary exertions were made to extinguish the flames. One apartment might be set on fire, but before the flames could spread to the one under or over it, or to a staircase adjoining it, the fire might be extinguished. In a house so constructed, there would be no piece of timber that was not in close contact with mortar, at least on one side; and all the strong pieces of timber, such as joists, rafters, quartering in partitions, &c., would be closely embedded in mortar on two sides. Where the partition could not be made entirely of brick, the interstices might be filled up with a mortar prepared of clay with a small proportion of lime. The same material might be filled in between the joists, and where it was desired to render the roof fire-proof, the rafters might be made of iron, or the space between wooden rafters might be filled in with thin mortar. This mode of proceeding would lengthen the time required for the drying of a newly-built house, and would also add somewhat to the expense; but it is conceived that the increased safety would more than counterbalance these inconveniences.

In respect to the means of giving a fire-proof quality to a house already built, Mr. Loudon remarks:—"All the interstices between the floors, in the partitions, and in the roof, where there was a ceiling formed to the rafters, might perhaps be filled in with earthy matter in a state of powder. This powder might be clay or loam mixed with a small proportion of Roman cement; it might be injected into the vacuities, through small orifices, by some description of forcing-pump or bellows, which, while it forced in the powder, would permit the escape of the air; and, while this operation was going forward steam might be injected at the same time, so as to mix with the mortar and be condensed by it; by which means the whole mass would be solidified with a minimum of moisture. In short, in rendering houses fire-proof, the next important object to using fire-proof materials, is that of having all the walls and partitions, and even the steps of wooden staircases, filled in with such materials as will render them in effect solid. On examining into the causes of the rapidity of the spread of the flames in London houses when on fire, it will almost invariably be found, that whatever may have occasioned the fire to break out, the rapidity of its progress has been in proportion to the greater or less extent of the lath and plaster partitions, the hollow wooden floors, and the wooden staircases. Were the occupiers of houses sufficiently aware of the danger from lath and plaster partitions, especially when inclosing staircases, they would never occupy such houses, or, if they did, they would not give such rents for them, as they would for houses with brick-nogging partitions. It appears to us to be the duty either of the general or local government or police to see that no houses whatever are built without stone or iron staircases; and that no partitions and floors are made hollow; or, if they are, that the materials should be iron and tiles, or slates, or stones, or cement, or other earthy composition."

Chapter XIII.

MISCELLANEOUS PROCESSES.

The various processes and details which have occupied the preceding chapters, are for the most part necessary to the production of every house. There are, however, many articles of iron and a few of brass employed in the interior and exterior fittings; but were we to enter into details respecting the iron manufacture, in order to show the modes of producing these articles, it would be difficult to confine this volume within reasonable limits. A few miscellaneous processes and details may, however, be collected in this chapter.

The principal metallic articles employed in the construction or permanent fittings of a house, are nails and screws; hinges; locks and keys; stoves and grates; bells, and the mechanism for hanging them; iron railings and bars; brass handles, plates, and other decorations; latches and fastenings, &c.

Nails.

Nails are made of iron, either *cut* by means of a machine into the tapering form which we call *cut brads*, or *wrought* by means of hammers into the various forms of flooring nails, tacks, &c. *Screws* are made by forcing a piece of iron wire into a cavity, the surface of which is cut into a spiral or screw-like form; this spiral cuts a similar spiral on the surface of the iron wire, which then becomes a screw; and one end of the wire is hammered or pressed down so as to form the *head* of the screw. *Hinges* of the commoner kinds are made by two flat pieces of iron, with a kind of projecting tube at one edge. These tubes are partially cut away, so that the two pieces may lap into each other; and a spindle or pin being passed down through both tubes, acts as an axis, on which both parts of the hinges turn. The more costly hinges require elaborate workmanship in their construction.

Locks and Keys.

Locks and *Keys* form a curious part of the hardware manufacture. The lock is made of a great many pieces, put together with screws. One part of it is always a moveable latch or bolt, which is capable, by tolerable force, of being thrust partially out through a hole in the side of the lock; and it is this bolt which, catching in a box or cell fixed to the door-post, secures the door to which the lock is attached.

The object of the key is to act as a lever which shall move the bolt; and the great point of attention in the matter is, that no key or lever but one of a particular *size* and *shape* shall be able to move the bolt; herein is the security which we feel in a good lock. Wolverhampton and its neighbourhood is the great seat of the lock manufacture.

Stoves and Grates.

Stoves and *Grates* are made in a variety of forms. Their employment is obviously greatly dependent on the kind of fuel employed. In the kitchens of the old baronial residences, large logs of wood were thrown upon an immense stone or brick hearth, and there kindled. But when coals became commonly used in London and other great towns of England, about the year 1400, the use of some kind of stove or grate began to be felt, since the fuel was too valuable to be scattered on a wide-spreading hearth. From that time to the present, one continual series of improvements has taken place, having for their objects, to add to the elegance and neatness of a room, to facilitate culinary occupations, and to derive the greatest possible heat from a given quantity of fuel. It is only within a very few years that the principles regulating the last-mentioned circumstance have been at all well understood. Some parts of the metal for a grate or stove are produced by casting, others by forging, and others by rolling or pressing; and they are put together principally by rivets. For further details on this subject we refer to our seventh chapter.

Bells.

Bells are, generally speaking, made of an alloy of copper and tin, which possesses more resonant qualities than most others. There is also a little ball or clapper suspended in the bell, which, by striking against it, produces the same effect as the hammer which strikes the outside of a church bell. The bell is generally fixed in a different part of the house from the handle with which it is rung, and the connexion between them is made by means of copper wire. As the wire has to turn round many corners and angles, it is fixed, at each corner to a *crank*, which is a kind of hinge or lever, so contrived as to transfer motion in a new direction at right angles to the former. Considerable care is required on the part of the bell-hanger, to prevent the wire from becoming entangled or interrupted in its free communication from the handle to the bell.

Brass Handles, Ornaments, &c.

These are produced by *turning*, by *casting*, by *stamping*, or by *drawing*. In the first mode, the article is placed in a lathe, and turned by tools made of hard steel: in the second mode, melted brass is poured into moulds formed generally of sand, by which any desired form is produced: in the third mode, two stamps, one called a *matrass* and the other a *die*, are cut or moulded to similar figures; a piece of sheet brass is laid on the matrass or lower stamp, the die or upper stamp is laid on the brass, and a powerful blow, either from a hammer, or from machinery, forces the brass to assume the form given to the two stamps. By the last mode, a slip of thin brass is forcibly drawn between two rollers, whose surfaces are indented with the requisite device, which device is thereby impressed on the bars. In one or other of these ways, most of the brass-work in our houses is made.

Iron railings and *bars* of various kinds are made either by forging or casting, and do not call for further notice here.

Preservation of Timber.

In our notices of the timber which enters into the construction of a house, no mention was made of the existing methods of preparing it so as to resist the action of dry rot and other decomposing agencies. Timber so prepared is not in very general use in house-building, and hence the notice of it occupies a more fitting place in the present chapter.

Vegetable matter, in common with all organic substances, is subject to decomposition and decay, as soon as life becomes extinct; and although the process is comparatively slower in its commencement and progress in vegetable than in animal matter, it is not, under ordinary circumstances, the less certain. During the existence of a plant, its various organs, under the influence of the mysterious principle of life, perform their respective functions in a manner similar to that of which we are more readily conscious in the animal frame. The plant absorbs its food from the soil and the surrounding air; it digests that food under the influence of respiration, and prepares rich and nutritive juices which circulate throughout its whole vegetable frame, and deposit materials of growth wherever they are wanted; it sheds its leaves in autumn, undergoes a season of torpor, and again becomes active and vigorous; thus it is clad in fresh leafy honours in the following spring. All this is the effect, or rather the result, of vitality. The plant dies, and then its constituent

parts gradually assert their individual existence, and resume their original affinities. Some pass into the air; some form new compounds; and others, which during the life of the plant ministered to its healthy action, now work energetically and destructively on each other; so that the original mass gradually decomposes under the influence of various causes. The first step to decay is a process of fermentation, which is more or less rapid in proportion as heat and moisture are more or less present. In the absence of damp air, even the vegetable mass will of itself supply moisture; for, according to Count Rumford, the best-seasoned timber retains one-fourth of its weight of water. A certain extent of moisture is essential to vegetable fermentation; but a complete saturation appears inimical to it. A temperature not so low as to produce freezing, nor so high as to produce rapid evaporation, is also favourable to it. The humidity of the air in ships, and in houses built on clay or in moist situations, and the difficulty of obtaining a free circulation of air, contribute greatly to this fermentative process.

The chemical constitution of the vegetable kingdom yields to analysis only three or four ultimate elements, viz., oxygen, hydrogen, and carbon, and sometimes nitrogen. The most active agent in the process of decomposition is the oxygen contained in the dead plant, whether such decomposition proceed under the rapid influence of fermentation, or be produced more slowly by the operation of the law which renders decay the necessary consequence of organization. As soon as the tree is felled, the oxygen begins to be liberated and to act upon the woody fibre, combining with its carbon, and producing carbonic acid gas. The tenacity of the several parts is thus gradually destroyed. After timber is felled, and during the process of seasoning, a gradual diminution of strength may be remarked. The effect, however, of seasoning is to deprive the wood of superabundant moisture, and of those vegetable juices which would otherwise induce a rapid decomposition.

In addition to the natural decay of timber, the decomposition is often accompanied by the apparently spontaneous vegetation of parasitical fungi, inducing a species of decay to which the term "dry rot" is applied, probably in consequence of the attendant phenomena; the wood being converted into a *dry* friable mass, destitute of fibrous tenacity. It is uncertain whether the seeds of these fungi exist in a dormant state in the juices of the timber, and wait only until the first stages of decomposition furnish them with a nidus favourable to their growth; or whether they float in the atmosphere and settle in places favourable to their vegetation. It is found,

however, that badly-seasoned timber is peculiarly subject to this species of decay; and hereby the former of the two suppositions is favoured.

From the moment when timber is felled, the process of decay commences, and although so slowly in many cases that we are not conscious of it, yet there is a limit to the existence of the most durable articles of wood, however carefully preserved. Dryness, cleanliness, a free circulation of air, or the entire exclusion of it, are among the best checks to vegetable decomposition: while damp accumulations, and a vitiated atmosphere, rapidly induce it.

Unseasoned timber should never be used in carpentry, and the best-seasoned timber should be used only in a dry state. Diseased and decayed portions of the wood should be cut out, together with the sap-wood, which, being more soft and porous than the spine, is more liable to fermentation.

The iron fastenings used about timber frequently cause its premature decay. Iron, under the influence of moisture becomes rusty, that is, oxygen, either from the air or from the wood itself, unites with the metal, forming an oxide, which, in its turn acts upon the woody fibre, and gradually destroys its tenacity. The iron is further subject to attack from the acid juices of the wood; this effect, however, varies in different woods. Oak contains a smaller proportion of oily or resinous particles than many other kinds of wood; and, in addition to the usual vegetable acid common to most woods, oak contains an acid peculiar to itself, called *gallic* acid. In teak, on the contrary, the quantity of acid is not only smaller, but the resinous particles are very abundant, and these form a sort of protecting covering to the iron fastenings. Maconochie states, on the authority of the shipping built in India and used in the India trade, that the average duration of an iron-fastened teak ship is thirty years; and that it is a misapplication of expense to use copper fastenings with teak, as the additional advantage gained is not at all commensurate with the additional expense. But it is different with oak; the action of oak on copper is by no means so destructive as on iron, and the reaction of the metal on the wood is not so destructive.

The methods which have been from time to time adopted for the preservation of timber are so numerous, that a slight sketch of them would probably fill a good-sized volume. We will name a few of the most successful, and terminate this notice with a description of the method now in practice.

Maconochie recommends all the iron fastenings to be provided with a protecting paint, and to impregnate the timber with some oily preparation, which he proposes to effect thus:

the wood is to be placed in a steam-tight chamber, and subjected to the action of steam, by which the air will be expelled from the timber. Then by condensing the steam, and repeating the process until all the elastic fluids are withdrawn from the wood, and its juices converted into vapour, the wood becomes freed from them, and if plunged into oil, and subjected to atmospheric pressure, all the internal cavities of the wood will be filled with oil. In this way, Maconochie had in daily use a steam-chamber capable of containing twenty or thirty planks of timber forty feet long, in which, while the planks were steaming, to render them flexible, they were impregnated with teak oil. He says the oil may easily be procured from the chips and saw-dust used for the fuel of the steam-boilers; for it has been ascertained that Malabar teak contains such a quantity of oleaginous (oily) or terebinthinous (turpentine) matter, that the chips from the timber and planks of a ship built of it will yield, by a proper process, a sufficient quantity of tar for all its own purposes, including the rigging; and that, although oak timber does not contain so much of these substances, the chips of the fir alone consumed in the Royal Navy, would be more than sufficient to supply tar to saturate the oak.

There have been many other proposals to saturate timber with different substances; the most successful of which, up to the process of Mr. Kyan, was that of M. Pallas, whose plan was to saturate the timber in a solution of sulphate of iron, and then precipitate the salt by means of lime-water. About the year 1822, Mr. Bill produced samples of timber impregnated throughout with a substance resembling asphaltum. These samples were subjected to a trial of five years in the dry-rot pit at Woolwich, and withstood the fungus-rot perfectly. Sir John Barrow recommends kreosote, which he says, "in a vaporous form, penetrates every part of the largest logs, and renders the wood almost as hard as iron—so hard as not easily to be worked."

Mr. Kyan's plan, now so universally adopted, is to soak the timber in a solution of bichloride of mercury, commonly called corrosive sublimate.

"Aware of the established affinity of corrosive sublimate for albumen, Mr. Kyan applied that substance to solutions of vegetable matter, both acetous and saccharine, on which he was then operating, and in which albumen was a constituent, with a view to preserve them in a quiescent and incorruptible state; and obtaining a confirmation of his opinions by the fact, that during a period of three years, the acetous solution, openly exposed to atmospheric air, had not become putrid, nor had the saccharine decoction yielded to the vinous or

acetous stages of fermentation, but were in a high state of preservation, he concluded that corrosive sublimate, by combination with albumen, was a protection against the natural changes of vegetable matter. He conceived, therefore, if albumen made a part of wood, the latter would be protected by converting that albumen into a compound of protochloride of mercury and albumen; and he proceeded to immerse pieces of wood in this solution, and obtained the same result as that which he had ascertained with regard to the vegetable decoctions."—BIRKBECK.

It having been found that the precipitate caused by the Kyanization was soluble in salt water, Sir William Burnett has lately substituted chloride of zinc for corrosive sublimate, and the resulting compound which this forms with the albuminous portion of the wood, effectually resists the action of salt water.

Soluble Glass.

A remarkable method of preserving wood-work, and rendering it fire-proof, was invented some years ago by M. Fuchs, in consequence of his discovery of a kind of glass which could be prepared and kept in a liquid state, and hardened only on being exposed in a thin layer to the air.

Soluble glass is a union of silica and an alkali, which has, in addition to some of the properties of common glass, the property of dissolving in boiling water. The preparation of soluble glass does not greatly differ in its early stages from that of common glass, an account of the manufacture of which will be found in the eighth chapter.

When sand and carbonate of potash are heated together, the carbonic acid is not entirely driven off, unless the sand be in excess, but the whole of the gas may be expelled by the addition of powdered charcoal to the mixture.

Carbonate of potash and pure sand being taken in the proportion of two to three, four parts of charcoal are added to every ten parts of potash and fifteen of sand. The charcoal accelerates the fusion of the glass, and separates from it all the carbonic acid, a small quantity of which would otherwise remain, and exert an injurious effect. In other respects the same precautions that are employed in the manufacture of common glass are to be observed. The materials must first be well mixed, then fritted, and finally melted at a high heat, until a liquid and homogeneous mass be obtained. This is removed by means of an iron ladle, and the glass pot filled with fresh frit.

The crude glass thus obtained is usually full of bubbles: it is as hard as common glass: it is of a blackish gray, and more

or less transparent at the edges. Sometimes it has a whitish colour, and at others is yellowish or reddish, indicating thereby that the quantity of charcoal has been too small. Exposed to the air for several weeks, it undergoes slight changes, which tend rather to improve than injure its qualities. It attracts a little moisture from the air, which slowly penetrates its mass without changing its aggregation or appearance, except that it cracks, and a slight efflorescence appears at its surface. If after this it be exposed to heat, it swells up, owing to the escape of the moisture it has absorbed.

In order to prepare the glass for solution in water it must be reduced to powder by stampers. One part of the glass requires from four to five of water for its solution. The water is first boiled in an open vessel, the powdered glass is added gradually, and is continually stirred, to prevent its adhesion to the vessel. The boiling must be continued for three or four hours, until no more glass is dissolved. If the boiling be checked before the liquor has thus attained the proper degree of concentration, carbonic acid will be absorbed by the potash from the air, and produce an injurious effect. When the solution has acquired the consistence of syrup, and a density of 1·24, it is fit for use. It is then allowed to repose, in order that the insoluble parts may be deposited: while it is cooling a film forms on the surface, which after some time disappears, or may be dissolved by depressing it in the liquor.

Soluble glass being employed only in the liquid state, it is preserved for use in solution. No particular care is necessary to preserve the liquid, as, even after a long space of time, it undergoes no perceptible change, if the solution have been properly prepared. The only precaution is not to allow too free an access of air to it.

Soluble glass may be prepared by using carbonate of soda, instead of that of potash. This glass has the same properties as the other, but is more valuable in its applications. The solutions of these two kinds of glass may be mixed in any proportion, and the mixture is sometimes more useful than either of the solutions separately.

The solution of soluble glass is viscid, and when concentrated becomes turbid or opalescent. The solution unites with water in all proportions. At a density of 1·28 it contains nearly 28 per cent. of glass, and if the concentration be carried beyond this point, it becomes so viscid that it may be drawn out in threads like molten glass. When the solution is applied to other bodies, it dries rapidly in the air, and forms a coat like a varnish; a property which leads us to notice

some of the numerous and varied applications of this curious preparation.

It is well known that all sorts of vegetable matter, such as wood, cotton, hemp, linen, paper, &c., are combustible, but in order to burn them, two conditions are necessary,—an elevated temperature, and free access of air to supply the oxygen necessary to their conversion into water and carbonic acid. When once inflamed their own combustion supplies the heat necessary to the chemical action, provided they be in contact with the air. If deprived of such contact, and made red-hot, they will yield inflammable volatile products, but the residual carbon will not burn, because deprived of air; and thus the combustion will cease of itself. Such is the property of all the fixed fusible salts, if they be composed of substances incapable of yielding their oxygen at a low red heat, either to carbon or hydrogen. Such salts melt as the vegetable matter becomes heated: they form upon it a coating impermeable by air, and either prevent or limit the combustion. The phosphate and borate of ammonia have such a character, but they are so readily soluble in cold water as to be liable to objections which are not found in soluble glass. This last-named substance forms a solid and durable coating, which suffers no change by exposure to the air (since soluble glass possesses the valuable property of being almost entirely unaffected by cold water): it does not involve any great expense, and is easy of application. But in order that it may not fail, particular care must be taken, both in preparing and employing it. To cover wood and other bodies with it the solution must be made of a pure glass, otherwise it would effloresce and fall off. But still a slight degree of impurity is not injurious, although after a few days a slight efflorescence will appear: this may be washed off by water, and will not occur a second time. When a durable coating is to be applied to wood, the first solution must not be too strong, for if it be it will not be absorbed: it will not displace the air from the pores, and consequently will not adhere strongly. A more concentrated solution may be employed for the after-coats, but each coat must be dry before another is applied, and the drying, in the most favourable weather, will occupy at least twenty-four hours. When the glass is made with potash the coating is liable to crack: this defect does not apply to glass made with soda.

Although soluble glass is of itself a good preservative from fire, yet it fulfils the object better when mixed with incombustible powders, such as those procured from clay, whiting, calcined bones, powdered glass, &c. In applying soluble glass to the wood-work of a public building at Munich, ten

per cent. of yellow clay or yellow earth was added. After six months the coating had suffered but little change: it was damaged only in a few places, where it had need of some repair. This arose from the very short time allowed for the preparation and application of the glass.

On Veneering.

In our notice of the interior fittings of houses of the better class, it was stated that the process of veneering is sometimes adopted for wainscoting. This process is most generally used for articles of furniture, and deserves to be noticed on account of its ingenuity.

The employment of wood for articles of domestic use or ornament, gives rise to many departments of mechanical labour, according to the manner in which the grain of the wood is to be made conspicuous or visible. In the antique pieces of furniture still existing in old mansions, the wood employed, such as oak, walnut-wood, mahogany, &c., was always solid; but in modern times, the desire of making a respectable appearance, at as small an outlay as possible, has led to the method of *veneering*,—that is, making some article of furniture of some cheap wood,—such as deal,—and then covering it with thin leaves or sheets of some more expensive and beautiful wood, such as rose-wood, maple, satin-wood, zebra-wood, pollard oak, &c. So very prevalent has this custom become, that almost every house now contains some article of domestic furniture, whose surface is covered with a kind of wood more valuable than that of which the bulk of the article is made.

It must be obvious, that the mode of procuring or preparing the thin leaves of veneer calls for great care and nicety, since they are seldom thicker than a shilling. When the method of veneering was first introduced, the sawing was effected by hand, in a manner more rude than the necessities of the case warranted; but when circular saws became introduced, they were found very efficacious for cutting veneers. Mr. Brunel, in 1805, took out a patent for improvements in the machinery for sawing timber, in which he employed a large circular saw, composed of several pieces fitted together, and placed in a frame at such an elevation that the lower edge was a little below the lower side of the timber. The timber was placed in a carriage, and moved towards the saw by a rack.

In such a manner as this veneers are now cut from the timber in this country. But it is stated that the Russians have devised a very curious and effective method of cutting veneers, without the use of a saw, and without making any

waste of material. It is a *planing* machine, the action of which is so accurate, that veneers thin enough for the covering of books, and for lithographic and other engravings, have been produced; thus serving the place of paper. The operation is begun by placing the timber from which the leaf is to be cut upon a square axle, where it is revolved, and made circular by a turner's gouge. The blade of a plane of highly-tempered steel, and rather longer than the cylinder of wood, is fixed at the extremity of a frame six or seven feet in length, in such a manner as to exert a constant pressure upon the cylinder, and pare off a sheet of equable thickness, which folds upon another cylinder like a roll of linen. The frame to which the blade is attached is moveable at its lower extremity, and by the action of a weight it depresses in proportion as the mass diminishes in substance. That this depression may be progressive and perfectly regular, the inventor has appended a regulator to the machine consisting of a flat brass plate, preserved in an inclined direction, upon which the frame descends as the regulator itself is advanced. The motion is communicated to the cylinder of wood by several cog-wheels, which are turned by a crank. One hundred feet in length of veneering may be cut by this machine in the space of three minutes.

When veneers are produced by the action of circular saws, as is now almost universally the case in England, it is evident that both surfaces must be rough, from the marks of the serrated edge of the cutting instrument; and it is in this rough state that they are purchased by cabinet-makers or others who employ them in veneering articles of furniture. The operations which are then to be performed are, to bring the surface of the veneer to a tolerable level, to fix the veneer to the article of furniture, and to clean and polish it when so fixed.

Supposing the top of a sideboard to be the article which is to be veneered. The workman cuts out a piece of veneer, a little larger than is actually required, to allow for waste; and then lays it flat on his work-bench. With a veneering plane—which is a small-sized plane, having an iron jagged with notches like the teeth of a very fine saw—he works steadily over the whole surface of the veneer, carrying the plane in the direction of the grain of the wood. The action of this plane-iron removes all the saw marks, which were irregular in their course, and gives instead of them a series of regular parallel channels from end to end of the piece of veneer; these channels are but small in depth, and their object is to retain the glue which is afterwards used in the process of veneering.

The surface of the deal or other wood on which the veneer

is to be laid, is in like manner planed with these parallel indentations; and then the process of veneering proceeds. The wood, having been well warmed before a fire, is coated with warm melted glue; and the piece of veneer is laid down flat on the veneered surface, and rubbed backwards and forwards, in order that the glue which is between the veneer and the under-wood may be pressed into all the little grooves produced by the plane. When the glue begins to get cool, the veneer can no longer be pressed to and fro, and is then left. This glueing has the general effect of making the veneer adhere to the foundation beneath; but there are parts where, from the accumulation of too much glue in one part, or from the presence of air which had not been expelled by the pressure of the hands, the veneer rises up as a kind of blister, convex on the upper surface. The workman employs a veneering hammer to level these protuberances. This veneering hammer is a piece of wood three or four inches long, and an inch in thickness, having a straight strip of iron plate fixed to one edge. The workman, placing the iron edge down upon the veneer, presses on the block of wood with his hand, and works all over the surface of the veneer, expressing all the superfluous glue from the parts which had formed the protuberances. As this redundant glue must have some place from whence to escape, the workman begins rubbing at the centre, and thence proceeds towards the edge, at which the glue finally exudes. There is a curious plan adopted for ascertaining whether there are any parts, imperceptible to the eye, where the veneer does not adhere closely to the foundation—viz., by sound. The workman strikes the veneer all over with a wooden or other hammer; and if the sound be distinct and solid, he knows that the proper degree of adhesion has taken place; but if the sound be hollow and dull, it indicates the existence of a vacant space between the veneer and the foundation; and a greater degree of rubbing or pressing is consequently necessary. If the surface of the piece of veneer be of large dimensions, two workmen are required to level all parts of the veneer before the glue gets cold and loses its fluidity.

But this operation—however good the glue may be, or however well the veneer may be pressed down—is not sufficient to cause the veneer to adhere permanently to the foundation, especially at the edges, where the air is liable to enter, and to cause the veneer to rise. To prevent this inconvenience, the veneer, at and near the edges, is kept down, either by the pressure of heavy weights, or, still better, by the action of screw-presses. These screw-presses consist of two pieces of wood or clamps, which are brought to any degree of closeness

by means of two wooden screws, each screw passing through holes in both clamps, the handles of the two screws being, respectively to each other, outside the opposite clamps. The clamps are opened, by means of the screws, to such a width as to admit the edge of the veneered wood between them; and the screws are then worked up till the clamps grasp the wood tightly, where they remain till the glue is quite cold, and the veneer closely adhering to the foundation.

But even all this care is not in every case sufficient to produce a firm adhesion of the veneer to the foundation. It frequently happens that, when the hardened veneered surface is tried with the hammer, a hollow sound indicates that there is yet a place where the veneer has a vacancy beneath it. In such a case, the only remedy is one of a curious kind—viz., to lay a hot iron on the defective part of the veneer, by which the glue beneath is remelted. A small part of the veneer, reaching from the defective part to the edge, is also similarly heated, and the glue beneath remelted. Then, by means of the veneering hammer, the superfluous glue which had caused the defect is squeezed out, and pressed to the edges of the veneer through the kind of channel which had been prepared for it by the heated iron.

Where the surface of the wood to be veneered is more or less cylindrical, such as a pillar, the front of a drawer, &c., the piece of veneer has a curvature given to it, corresponding in some degree to that of the surface on which it is laid, by the action of hot water, before the glueing is effected. By sponging one side of the veneer with hot water, it causes that side to swell, while the other side remains dry; the consequence of which is, that the wetted surface rises into a convex form, leaving the other side hollow or concave:—this is, in fact, an instance of *warping*, where a thin piece of wood is either unequally heated or damped on opposite sides. The hollow side is then laid on the glued foundation.

When the veneered surface is dry, its edges are trimmed, and its surface scraped and sand-papered, preparatory to the finishing processes which the piece of furniture is to undergo.

Manufacture of Glue.

The preparation of this useful article forms a curious and important branch of national industry. The chief use of glue is for binding or cementing pieces of wood together, as practised by the carpenter and cabinet-maker, in which trades very large quantities are constantly employed.

Glue (which is nothing more than gelatine in a dry state) is obtained from the hides, hoofs, and horns of animals; the

refuse of the leather-dresser, and the offal of the slaughter-house; ears of oxen, calves, sheep; parings of parchment, old gloves; and, in short, animal skin and (by a late improvement) bones, are all employed for making glue.

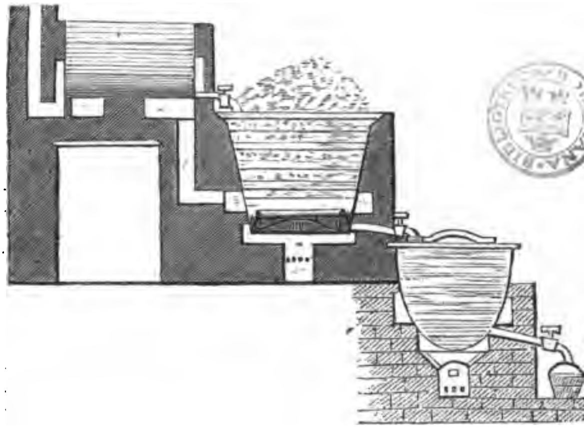
The first process in this manufacture is to free the materials from dirt, blood, and other matters which do not afford glue. For this purpose they are steeped in lime and water, and then placed in baskets, and rinsed by the action of a stream of water. They are then removed to a sloping surface, and allowed to drain, and whatever lime remains is deprived of its caustic property by the reabsorption of carbonic acid from the atmosphere, since the presence of lime would prove injurious in the subsequent processes.

The gelatine is removed from the animal matter by boiling. This process is effected in a somewhat shallow boiler, which is provided with a false bottom, pierced with holes, and elevated a few inches, thus serving as a support to the animal matter, and preventing it from burning by the heated bottom of the boiler. The boiler is filled about two-thirds with soft water, and then the animal substances are added: these are piled up above the brim of the boiler, because soon after boiling commences, they sink down below the level of the liquid. The contents of the boiler are occasionally stirred up and pressed down, while a steady boiling is maintained throughout this part of the process.

As the boiling proceeds, small portions of the gelatine are drawn off into egg-shells, when, in the course of a few minutes, if the liquid gelatine becomes, by exposure to the cool air, a clear mass of jelly, the boiling process is complete, —the fire is smothered up, and the contents of the boiler left to settle for ten or twenty minutes. The stop-cock is then turned, and the gelatine flows into a deep vessel, kept hot by being surrounded with hot water, and thus it remains for several hours, during which time it deposits any solid impurities. It is then drawn off into congealing boxes, and prepared as we shall soon explain.

The undissolved matter in the boiler is treated with boiling water a second, and even a third time, and the above process continued until nothing more can be extracted. The subsequent solutions are often too weak to be made into glue, but they are economically used with fresh portions of animal matter.

A clear idea may be formed of this part of the manufacture by the annexed illustration, which represents a section of three vessels, on different levels. The uppermost vessel, which is heated by the waste heat of the chimney, supplies warm water to the animal matter contained in the second



vessel: the third vessel receives the liquid gelatine, and retains it in a fluid state, while the solid impurities are being deposited.

The gelatine is drawn off from this third vessel into buckets, and conveyed to the congealing boxes. These boxes are of deal, of a square form, but somewhat narrower at bottom than at top. The liquid glue is poured through funnels, provided with filter-cloths, into the boxes until they are entirely filled. This process is conducted in a very cool and dry apartment, paved with stone and kept very clean, so that any glue which may be spilt may be recovered. In twelve or eighteen hours the liquid glue becomes sufficiently firm for the next process, which is performed in an upper story, furnished with ventilating windows, so as to admit air on all sides. The boxes are inverted on a moistened table, so that the cake of jelly may not adhere to it: this cake is cut into horizontal layers, by means of a brass wire, stretched in a frame, and is guided by rulers, so disposed as to regulate the thickness of the cake of glue. The slices thus formed are carefully lifted off, and placed on nets stretched in wooden frames. As these frames are filled they are placed over each other, with an interval of about three inches between every two frames, so that the air may have free access. Each frame is so arranged as to slide in and out like a drawer, to allow the cakes to be turned, which is done two or three times every day.

An experienced writer on manufactures thus observes, concerning this part of the process:—“The drying of the glue

is the most precarious part of the manufacture. The least disturbance of the weather may injure the glue during the two or three first days of its exposure. Should the temperature of the air rise considerably, the gelatine may turn so soft as to become unshapely, and even to run through the meshes upon the pieces below, or it may get attached to the strings and surround them, so as not to be separable without plunging the net into boiling water. If frost supervene, the water may freeze, and form numerous cracks in the cakes. Such pieces must immediately be remelted and reformed. A slight fog even produces upon glue newly exposed a serious deterioration, the damp condensed upon its surface occasioning a general mouldiness. A thunder-storm sometimes destroys the coagulating power in the whole laminæ at once, or causes the glue to *turn* on the nets, in the language of the manufacturer. A wind too dry or too hot may cause it to dry so quickly as to prevent it from contracting to its proper size, without numerous cracks and fissures. In this predicament the closing of all the flaps of the windows is the only means of abating the mischief. On these accounts it is of importance to select the most temperate season of the year, such as spring and autumn, for the glue manufacture."

When the glue is properly dried a gloss is imparted to each cake, by dipping it in hot water, and passing over it a brush, also wetted with hot water. The cakes are then placed on a hurdle, dried in the stove-room, or in the open air, if the weather be sufficiently dry and warm. It is then packed in casks for sale.

It has been found by experiment that when two cylinders of dry ash, one inch and a half in diameter, were glued together, and after twenty-four hours torn asunder, a force of 1260 pounds was required to produce the separation, thus making the force of adhesion equal to 715 pounds per square inch. Another experiment made the force of adhesion to equal 4000 pounds on the square inch.

The House-Decorator of Italy.

In an interesting notice, by Mr. Wilson, of the present state of the arts in Italy, read before the Society of Arts, in Scotland, in November, 1840, a few details are given of the skill with which the house-builder converts the commonest materials into tasteful decorations. The following is an abstract of that part of the notice which relates to the subject of the present volume:—

Notwithstanding the comparatively small employment afforded to Italian architects in the present day, yet there

can be no question as to the skill displayed in erecting their designs. The masonry is excellent, and the ancient Roman brick-work is rivalled by that of the present generation; houses are built of brick, in which all the exterior decorations are moulded in that material as perfectly as if executed in stone. The skill with which the Italian workmen build in brick, may be exemplified by the Florentine practice of arching over rooms without centering of any description. Two thin moulds of board, the shape of the intended arch, alone are used: these are placed at each end of the apartment which it is intended to cover in, and pieces of string are stretched from the one to the other, guiding the workman as he advances in the formation of his arch, which he builds, uniting the bricks by their thin edges (greatly thinner than those we use), and trusting entirely to the tenacity and quick-setting of the cement.

Plastering is also carried to a perfection in Italy, of which we have very little idea in this country; rooms are so exquisitely finished, that no additional work in the shape of house-painting is required; but the polish of the plaster, and its evenness of tint, are such as to rival those of the finest porcelain. Sometimes the plaster is fluted, or various designs are executed in *intaglio* upon it, in the most beautiful manner. Scagliola, a very fine preparation from gypsum, is the material chiefly used. An instance of the cheap rate at which this work is done, is afforded in the new ball-room in the Palazzo Pitti grand-ducal residence at Florence, which, including mouldings, figures, bas-reliefs, and ornaments, was executed at a cost of two crowns for every four square feet.

A most beautiful art among the Italians, and one which might be advantageously introduced into this country, is that of making what are termed Venetian pavements. This method of finishing the floors of rooms is conducted in the following manner. In the first place a foundation is made of lime mixed with pozzolana, and small pieces of broken stone; this is, in fact, a sort of concrete, which must be well beaten and levelled. When this is perfectly dry, a fine paste, as it is termed by the Italians, must be made of lime, pozzolana, and sand; a yellow sand is used which tinges the mixture; this is carefully spread to a depth of one or two inches, according to circumstances. Over this is laid a layer of irregularly broken minute pieces of marble of different colours, and if it is wished these can be arranged in patterns. After the paste is completely covered with pieces of marble, men proceed to beat the floor with large and heavy tools made for the purpose; when the whole has been beaten into a compact mass, and the paste appears above the pieces of marble, it is

left to harden. It is then rubbed smooth with fine-grained stones, and is finally brought to a high polish with emery powder, marble dust, and lastly, with boiled oil rubbed on with flannel. This makes a durable and very beautiful floor, which in this country would be well adapted for halls, conservatories, and other buildings.

The carpentry of the Italians, as observable in ordinary houses, displays little skill and indifferent workmanship, but in the roofs and floors of important buildings, they satisfactorily prove their knowledge of scientific principles, and several of their designs are well known to British architects.

With regard to the working of iron, in comparison with our system, the Italian is primitive indeed; yet at times he can and does produce very good specimens of workmanship, but at a heavy cost; consequently they are generally content with very ordinary productions. A manufactory of wire, and of driving and screw nails, by means of machinery, now occupies the villa of Mecænas at Tivoli; the articles produced are very well made. Copper is extensively used in Italy, and there are productive mines in the *Maremma Toscana*. The workmanship of articles made of this metal is respectable; various utensils are made of brass in a neat and satisfactory manner, but in the interior finishing of houses, if much nicety is required, articles of foreign manufacture are used.

House-painters may be mentioned in the last place, and these display much taste and skill; and there is a class of them who greatly excel those in this country, having more the feeling and taste of artists. Surrounded by the finest models in this art, the Italian decorator enjoys every advantage in its study, and he inherits besides from the best periods of art, or rather from antiquity, taste, and a good system of workmanship. He is not a mere machine, employed in the use of the moulds, stamps, and other mechanical contrivances, which too often keep the decorative arts within such narrow limits.

Fresco Painting.

The proposed introduction of Fresco Painting into our public buildings will, it is hoped and expected, have the effect of employing the artist in fresco upon the walls of our dwelling-houses. Already have a few of the mansions of our nobility been thus decorated, and in anticipation of its general introduction it may not be out of character with this little work to describe the process in detail.

Respecting the origin of the term fresco there are two opinions; according to some the term is said to have been

adopted because the practice of it is used in the open air. Thus in the Italian language, *andare al fresco* signifies "to take the air;" or "to walk abroad in the air;" but a more probable explanation is to be found in another meaning of the word fresco, viz., "new," or "fresh," as applied to the state of the plaster in which it is wrought. The artist traces his design, colours it, and completely finishes in one day so much of his picture as will occupy the wet plaster ground that has been prepared for him, so that when the ground is dry, he may not retouch any part of his work. This is the characteristic distinction of painting in fresco—a method by which the painting is incorporated with the mortar, and drying along with it becomes extremely durable, and brightens in its tones and colours as it dries.

It will therefore be readily conceived that the artist in fresco has to encounter difficulties of no ordinary kind; a few of them are thus noticed by a writer in REES's *Cyclopædia:*—"From the necessity there is in the progress of this style of art, that it should be executed with rapidity, and from the impossibility of retouching it without injuring the purity of the work, the artist, unless he be endowed with very extraordinary powers of imagination and execution indeed, is obliged to prepare a finished sketch of the subject, wrought to its proper hue and tone of colour, and so well digested, that there may be no necessity for making any essential alterations in the design. This, which is a very useful mode of proceeding in all fine works of painting, is absolutely indispensable in fresco, to those who are not determined to give the rein to their ideas, and leave as perfect whatever may first present itself. There is no beginning in this, by drawing in the whole of the parts at one time, and correcting them at leisure, as is the custom with oil-painters, who may therefore proceed to work without a sketch; here all that is begun in the morning must be completed in the evening; and that almost without cessation of labour, while the plaster is wet; and not only completed in form, but also, a difficult, nay, almost impossible task, without a well-prepared sketch, must be performed, viz., the part done in this short time must have so perfect an accordance with what follows, or has preceded, of the work, that when the whole is finished, it may appear as if it had been executed at once, or in the usual mode, with sufficient time to harmonize the various forms and tones of colour. Instead of proceeding by slow degrees to illuminate the objects, and increase the vividness of the colours, in a manner somewhat similar to the progress of nature in the rising day, till at last it shines with all its intended effect, which is the course of painting in oil,

the artist working in fresco must at once rush into broad daylight, at once give all the force in light, and shade, and colour, which the nature of his subject requires, and this without the assistance (at least in the commencement) of contrast to regulate his eye; so that here, as has been said, a well digested and finished sketch seems indispensably requisite."

The custom of decorating walls with paintings is very ancient. Those discovered by Belzoni, among the royal tombs of Egypt, prove the existence of the art among the Egyptians many centuries before the Christian era. There is also abundant evidence that it was practised by the Etruscans and Romans. But the more common practice up to the time of Augustus seems to have been to paint the walls of houses of one single colour, and to relieve this with fantastic ornaments. According to Pliny, Augustus was the first to suggest the covering of whole walls with pictures and landscapes. About the same time a painter named Ludius invented that style of decoration, now called *arabesque* or *grotesque*, many beautiful examples of which have been discovered at Pompeii and other places. The invention of the Arabesque style, as its name implies, has been improperly claimed for the Arabians of Spain; whose religion forbidding the representation of animals, they employed foliage, stalks, stems, tendrils, flowers, and fruit, in a variety of forms and combinations, with which they adorned the surfaces of their buildings. Hence the fanciful combinations of natural objects occupying a flat surface came to be called Arabesque, although it differed so much from the Mohammedan compositions as to contain animals real or fabulous. That the term is badly chosen, especially as applied to the fanciful enrichments on the walls of Pompeii, &c., will be seen from the fact that such ornaments were invented and executed long before the sons of Ishmael had learned to draw. The term grotesque is less objectionable: it is derived from the subterranean rooms (grotte) in the baths of Rome, in which those specimens of ancient art were found, from which Raphael derived the plan of the beautiful frescos which adorn the piers and pilasters of the arcaded gallery of the palace of the Vatican, called, in honour of the artist, "Le Logge di Raffaelle."

The practice of Fresco Painting may be conveniently considered under the following heads:—1. The cartoon. 2. The preparation of the wall. 3. The process of painting. 4. The colours and implements. The methods as adopted by different artists are of course subject to variation; but as general principles are not altered by variations in those details which conduce to the same end, so the following

may be taken as an accurate exposition of the practice of the art.

1. *The Cartoon*. Since the artist cannot without injury retouch a fresco painting, it is necessary that every part of the design be decided on by preparatory sketches finished of the full size, from which the fresco may be transferred, by tracing to the wall. When the painting is very large, the whole composition of the full size is sometimes divided into two or more cartoons.

In the preparation of a cartoon, a strong cloth is stretched on a frame, as if to be prepared for painting; paper is then firmly glued on the cloth. When this is dry, a second layer of paper is attached by glue. The edges of the separate sheets, where they overlap, are scraped, so as to preserve an even surface. The surface is then prepared for drawing with size and alum.* The drawing is made with charcoal, and when finished is fixed by wetting the cloth at the back with cold water, and then steaming the drawing in front. The steaming is performed with a tea-kettle with two or three spouts, kept boiling by the flame of a spirit lamp; by this means the charcoal is incorporated with the melted glue, and a solid surface like that of a picture is produced.

From this finished drawing the outline is traced on oiled paper. As much of this working outline as can be finished in one painting is then nailed to the wet wall, and the forms are again traced with a sharp point, whereby an indented outline is produced on the soft plaster. According to another method, the paper to be applied to the wall is placed behind and in close contact with the finished cartoon; the outlines of the latter are then pricked, and a similar pricked outline is thus produced on the paper behind. This pricked paper is then made the working drawing: it is fastened to the wall, and dusted with a little bag filled with black or red dust; this leaves a dotted outline on the wall. This method is sometimes adopted for small works, and the advantage of it is that it leaves the surface of the plaster undisturbed. The first mode is, however, generally preferred; since it insures the best and most decided outline, and preserves the finished cartoon uninjured.

Cartoons prepared for fresco may be seen in the National Gallery: those at the head of the staircase are by Agostino Caracci. In one of these (the Triumph of Galatea) the pricked outline is very apparent; as also in the fragment of the Cartoon by Raphael, (the Murder of the Innocents,) also

* The term Cartoon is derived from *cartone*, the augmentative of *carta*, the Italian for *paper*.

in the National Gallery. In many celebrated Italian frescos the indented outline, produced by tracing, is apparent.

In addition to the cartoon it is desirable to have a coloured sketch of the whole composition.

2. *The preparation of the Wall.* The greatest obstacle to the permanence of fresco painting is damp: hence, if the wall to be painted is covered with old mortar, the ingredients of which are unknown, this coat should be entirely removed until the solid brick or stone is laid bare. The rough coat then applied is composed of river-sand and lime, and of such thickness as is generally used in preparing the walls of dwelling-houses. The surface of this coat should be rough, but not uneven. Thus prepared, the wall should be suffered to become perfectly dry and hard; the longer it remains in this state the safer it will be, especially if the lime used was in the first instance fresh. In that case two or three years should elapse before the process of painting is commenced.

The preparation and seasoning of the lime is one of the essential conditions of fresco painting. At Munich it is made and kept as follows:—A pit is filled with clean burnt limestone, which is slaked, and then stirred continually till it is reduced to an impalpable consistence. The surface having settled to a level, clean river-sand is spread over it to the depth of a foot or more, so as to exclude the air, and, lastly, the whole is covered with earth. It is allowed to remain thus for at least three years before it is used, either for the purposes of painting (lime being the white pigment) or for coating the walls.

The last preparation for painting on the mortar, is as follows:—The surface is wetted with pure water, till it ceases to absorb. A thin coat of plaster is then spread over that portion only which is to be painted: the surface of this coat should be moderately rough. As soon as it begins to set (*i. e.*, in about ten minutes or so, according to the temperature) a second thin coat is laid on, and the surfaces are smoothed with a wooden trowel. Some painters like to work on a perfectly smooth surface, in which case the last coat is polished by applying a piece of paper on the surface, and passing the trowel over it. When a small amount of roughness is required, a dry brush, or a piece of beaver nap attached to the trowel, is passed over the plaster in all directions.

3. *The process of Painting.* The wall being properly prepared, the outline of the figures is to be traced with a sharp point on the plaster, as before described. The artist commences his work when the surface is in such a state that it will barely receive the impression of the finger, and not so wet as to allow the colours to run or to be liable to be stirred up

by the brush. If the wall has been previously well wetted, it will in general not dry too rapidly; but if in warm weather the surface becomes too hard to imbibe the colour properly, a small quantity of water is from time to time sprinkled over the surface.

The colours being ground fine in water, and the most useful tints abundantly supplied, they are arranged in pots or basins, and several palettes with raised edges are ready at hand to work from. A few pieces of tile or some absorbent material are provided to prove the tints upon, because all colours ground in water become much lighter when dry than they appear when wet. The brick absorbs the water, and leaves the colour nearly in the state in which it will appear upon the wall.

The first tints that are applied sink in and have a faint appearance; it is therefore necessary to go over the work several times before the full effect is produced: but after some time the last edition of colour will not unite with that already applied unless the part be again wetted.

At the close of a day's work, any portion of the prepared plaster which remains over and above the finished part is to be cut away, care being taken to make the divisions at a part where drapery, or some object or its outline, forms a boundary, for if this be not attended to, the work will appear patchy. The next day, in preparing a new surface, the edges of the previously painted portion must be carefully wetted so as to ensure a perfect junction of all the parts of the painted surface.

At Munich the artists have a contrivance for arresting the drying of the work should they be unable to finish the day's allotted portion. A piece of fine linen is wetted and spread over the fresh plaster and painting, and pressed to the surface by means of a cushion covered with waxed cloth.

Defects are sometimes remedied by cutting out the objectionable portion, and painting it anew upon a fresh surface of plaster. In the finished fresco, shadows are sometimes deepened, parts are rounded, subdued, or softened by hatching in lines of the colour required, mixed up with vinegar and white of egg. Crayons made of pounded egg-shells are sometimes used to heighten the lights. But all these additional amendments are highly objectionable; they impair the durability of the fresco, and in the open air these retouchings are useless, because the rain washes them away, whereas it has no influence upon frescos painted without retouching.

4. *The Colours and Implements.* The colours employed in fresco painting are few and simple. They consist chiefly of earths and a few metallic oxides variously prepared. No

animal and vegetable substances can be used, because the lime would destroy them. The brushes are of hog's hair, but longer than those used in oil painting. Small pencils of otter hair are also used; no other hair being found to resist the lime. Pure distilled water ought to be employed in all the operations of this art.

Such is the process of fresco painting, the details of which, after the above statement, will be rendered more intelligible by the following abridged account of a visit, by Mr. Andrew Wilson, to the royal palace at Genoa, to see the Signor Pasciano paint a ceiling in fresco:—

The artist had prepared his tints upon a table with a large slate for the top: they consisted of terra vert, smalt, vermilion, yellow ochre, Roman ochre, darker ochre, Venetian red, umber, burnt umber, and black. These colours were all pure, mixed with water only, and rather stiff. He mixed each tint as he wanted it, adding to each from a pot of pure lime, or from one containing a very pale flesh tint. A lump of umber served to try his colours on. He used a resting-stick with cotton on the top to prevent injury to the prepared wall, or *intonaco*, as the Italians call it. The moment this surface would bear touching, the artist began to work upon the figure, the outline of which had just been traced. The head was that of the Virgin. The artist began with a pale tint of yellow round the head for the glory: he then laid in the head and neck with a pale flesh colour, and the masses of drapery round the head and shoulders with a middle tint, and with brown and black in the shadows. He next, with terra vert and white, threw in the cool tints of the face; then with a pale tint of umber and white, modelled in the features, covered with the same tint the part where the hair was to be seen, and also indicated the folds of the white veil. All this time he used the colours as thin as we do in water colours; he touched the intonaco with great tenderness, and allowed ten minutes to elapse before touching the same spot a second time. He now brought his coloured study, which stood on an easel near him, and began to model the features, and to throw in the shades with greater accuracy. He put colour in the cheeks, and put in the mouth slightly, then shaded the hair and drapery, deepening always with the same colours, which became darker and darker every time they were applied, as would be the case on paper for instance. Having worked for half an hour, he made a halt for ten minutes, during which time he occupied himself in mixing darker tints, and then began finishing, loading the lights, and using the colours much stiffer, and putting down his touches with precision and firmness: he softened with a brush with a little water in it.

Another rest of ten minutes; but by this time he had nearly finished the head and shoulders of his figure, which being uniformly wet, looked exactly like a picture in oil, and the colours seemed blended with equal facility. Referring again to the oil study, he put in some few light touches in the hair, again heightened generally in the lights, touched too into the darks, threw a little white into the yellow round the head, and this portion of his composition was finished, all in about an hour and a half. This was rapid work, but it will be noticed that the artist rested four times, so as to allow the wet to be sufficiently absorbed into the wall to allow him to repass over his work. He now required an addition to the intonaco; the tracing was again lifted up to the ceiling, and the space to be covered being marked by the painter, the process was repeated, and the body and arms of the figure were finished.

On the occasion of a second visit, Mr. Wilson remarked that the artist had cut away from his tracing or cartoon those parts which he had finished upon the cieling: that the tracing was in fact cut into several portions, but always carefully divided by the outline of figures, clouds, or other objects. These pieces are nailed to the plaster, so as to fold inwards or outward for the convenience of tracing the outlines. The artist was now about to proceed with a group of figures. Having gone over the outline carefully with a steel point, he waited till the intonaco became a little harder, and in the mean time mixed up a few tints; he then commenced with a large brush, and went over the whole of the flesh; he next worked with a tint which served for the general mass of shadow, for the hair, and a slight marking out of the features. He now applied a little colour to the cheeks, mouth, nose, and hands, and all this time he touched as lightly as possible. He then paused for ten minutes, examined his oil study, and watched the absorption of the moisture.

The intonaco would now bear the gentle pressure of his fingers, and with the same large brush, but with water only, he began to soften and unite the colours already laid on. He had not as yet used any tint thicker than a wash of water-colour, and he continued to darken in the shadows without increasing the force or depths of colour. The artist now increased the number of his tints; he made them of a much thicker consistence, and he now began to paint in the lights with a greater body of colour, softening them into the shades with a dry brush, or with one a little wet, as was required. In drying, the water comes to the surface and actually falls off in drops, but this does no harm, although, as Mr. Wilson remarks, it sometimes looks alarming.

The effect of fresco painting is described as being exceedingly beautiful. It does not require for the production of its general effect those particular and concealed lights which the shining surface of an oil-painting renders necessary. Fresco is seen entire in any situation and by any light, even by artificial light, which perhaps shows it best. Mr. Severn was much struck by the increased beauty and power of the Caracci frescos at Rome by artificial light. Even a dim or diminished light does not destroy their effect.

"It must have been for this reason that Raphael adopted fresco in the Vatican, after he had made experiments in oil; for the rooms are so ill-lighted, that oil pictures could never have been seen at all; and it is surprising to find such fine works in such a place. Three sides of the rooms are illuminated merely by the reflected light from the great wall of the Sistine chapel, yet this beautiful and luminous material of fresco is so brilliant in itself, that the pictures are well seen. Nine of them were painted without a ray of real light, and have always been seen in the same way. I think this is a very important consideration; for as we have but a diminished light at any time, it is most necessary to adopt a manner of painting suited to it, which can be seen at all times."

Fresco does not seem to be at all understood in this country; it is generally confounded with scene painting; it is a common mistake to suppose that the cartoons of Raphael are the same as his frescos. It is often confounded with distemper painting, which is done on a dry ground, and does not admit of richness of colour.

"This will be clearly understood (writes Mr. Severn) by those who have had the good fortune to see Raphael's and Guido's frescos at Rome, which for colour are exquisitely beautiful, and even powerful in all the fascinations of this part of the art, presenting to us still greater varieties than oil painting can pretend to; excelling in all the delicate effects of atmosphere, from the gorgeous daylight, the air of which you seem to breathe in a fresco picture, down to the silvery flitting charm of twilight. In these particulars, it reminds us of English water-colour effects. Then I should mention the magnificence of fresco landscape, and of landscape backgrounds, particularly by Domenichino, in which not only the characters, but the movements of trees, are always rendered in a way which I have rarely seen in oil colours. . . Then I must remind you of the grandeur of colour and effect in Michael Angelo's frescos on the ceiling of the Sistine chapel. What oil could ever have approached such things? When he said 'that oil painting was only fit for women and children,' he meant on account of the labour and difficulties of the

material compared with fresco. We are assured he performed this gigantic labour in twenty months, without the usual assistance of colour-grinders or plasterers, but alone with his own hand. There are on this ceiling fourteen figures, of at least forty feet in stature, and nearly five hundred figures, the least of which are double the size of life. While we regard this as the most extraordinary example of individual human power, we must consider that it was only in the simplicity and ease of the fresco material that Michael Angelo could have accomplished such a stupendous work. The preparation of oil colours, varnishes, &c., would alone have occupied the twenty months."

The small cost and great durability of frescos are not the least of their advantages. It was feared that the smoke of London would soon destroy our frescos, but Professor Hess stated that "if frescos were painted in the open air in London, the rain would be the best picture-cleaner." Indeed, competent authorities agree that pure water and a soft sponge are the best means for cleaning frescos from the effects ot smoke. That the change effected by time on the colours is to increase their effect. The great enemy to fresco is a wall constitutionally damp, in which lime in too new a state has been employed, or new timber or imperfectly burnt bricks. The nitre which sometimes accumulates on walls is also very destructive.

Nor are frescos such permanent fixtures as is generally imagined. Some ingenious Italians have succeeded perfectly in removing large frescos from one wall and applying them securely to another. The colours in fresco do not penetrate very deep, and the thin layer of pigment and lime of which the painting consists, may be removed by glueing several layers of calico to the wall: a slight force is then sufficient to detach the painting: it is removed to its new bed, and when firmly attached, the cloths and glue may be removed by warm water.

We must now leave the Reader in possession of the dwelling-house which we have endeavoured to build for him. If we have not *furnished* it, or described the modes in which the various articles of furniture are made, it was not because the subject is devoid of interest, far from it; but because we were anxious not to injure the completeness and interest of the preceding details by attempting too much within the limits of this little volume.

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